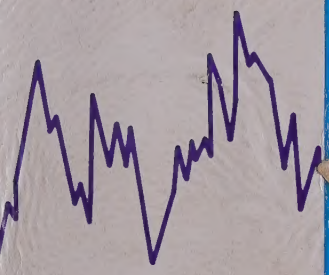
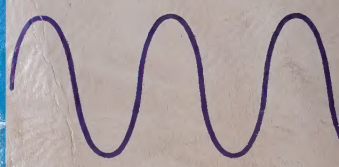
SD104-5M

INSTRUCTION MANUAL

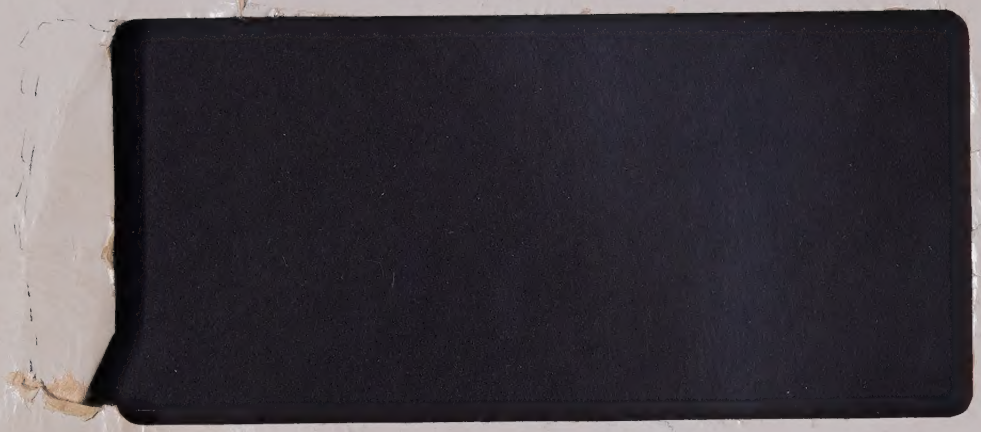
SD104-5
SWEEP OSCILLATOR

(PAT. PEND.)





SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO



Pete Gillis
714 - 278-2501
San Diego

SERIAL NUMBER 96

INSTRUCTION MANUAL

SD104-5
SWEEP OSCILLATOR

(PAT. PEND.)

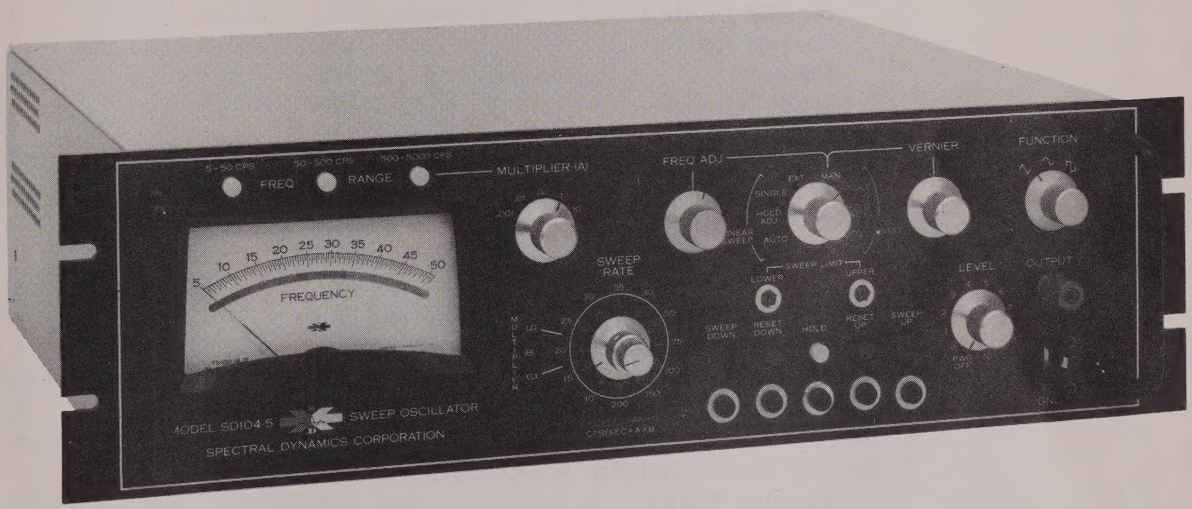
PROPRIETARY RIGHTS of Spectral Dynamics Corporation of San Diego are involved in the subject-matter of this material and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient by accepting this material agrees that this material will not be used, copied or reproduced in whole or in part nor its contents revealed in any manner or to any person except to meet the purpose for which it was delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

P. O. Box 671
San Diego, California 92112

Telephone: (714) 278-2501

15 April 1965



MODEL SD104-5 SWEEP OSCILLATOR

TABLE OF CONTENTS

SECTION		PAGE
I	GENERAL INFORMATION	
	1.1 Shipping and Inspection Procedure	1
	1.2 Claim for Damage in Shipment	1
	1.3 Warranty	1
	1.4 Return Shipment Procedure	1
	1.5 Specifications	
	Frequency Range	2
	Outputs	2
	Sweep Modes	3
	Sweep Rates	4
	Power	4
	Size	4
	Shipping Weight	4
	1.6 General Description	4
II	OPERATION	
	2.1 General	5
	2.2 Frequency Meter & Multiplier (A) Switch	5
	2.3 Frequency Adjust & Vernier Controls	5
	2.4 Function Selector Switch	6
	2.5 Level Control	6
	2.6 Sweep Rate & Multiplier (B) Switch	6
	2.7 Sweep Mode Switch & Pushbuttons	
	Manual Mode	6
	External Mode	7
	Upper & Lower Limit Adjustments	7
	Single Sweep Mode (Log or Linear)	7
	Auto Sweep Mode (Log or Linear)	8
	Hold Adjust Mode (Log or Linear)	8
	Hold Function	8
	2.8 Typical Operation	8
	2.9 Sweep Rate Conversion	9
III	THEORY OF OPERATION	
	3.1 Introduction	13
	3.2 Sweep Generator	13
	3.3 Voltage Controlled Oscillator (VCO)	14
IV	CALIBRATION	
	4.1 Introduction	19
	4.2 Meter	19
	4.3 Power Supply	19
	4.4 Meter Calibration	19
	4.5 Chopper Drive	20
	4.6 Up Reset Servo	20

TABLE OF CONTENTS

SECTION			PAGE
IV	CALIBRATION (Cont'd)		
	4.7	Offset Adjustment	21
	4.8	Triangle Wave Adjustment	21
	4.9	Symmetry Adjustment	21
	4.10	Sweep Zero Adjustment	21
	4.11	Sweep Upper Limit	22
	4.12	Log Converter	22
	4.13	Sweep Time	23
	4.14	Linearization	23
	4.15	Sine Shaper	24
	4.16	Output Amplifier	24
	4.17	Hold Drift	24
V	REPLACEABLE PARTS		
	5.1	General	27
	5.2	Special Replaceable Parts List	27

LIST OF ILLUSTRATIONS

FIGURE		
1.	Front Panel View	10
2.	Rear Chassis View	11
3.	Simplified Block Diagram, Model SD104	15
4.	Detailed Block Diagram, Model SD104	17
5.	Top View	25
6.	Bottom View	26
7.	Component Location - Circuit Card A1 Meter Circuit Assembly 23024-1	Rear
8.	Schematic - Circuit Card A1	Rear
9.	Component Location - Circuit Card A2 High Frequency Switch & Buffer Assembly 23022-1	Rear
10.	Schematic - Circuit Card A2	Rear
11.	Component Location - Circuit Card A3 Inverter Amplifier Assembly 23048-1	Rear
12.	Schematic - Circuit Card A3	Rear

TABLE OF CONTENTS

FIGURE		PAGE
13.	Component Location - Circuit Card A4 High Frequency Integrator Assembly 23046-1	Rear
14.	Schematic - Circuit Card A4	Rear
15.	Component Location - Circuit Card A5 Log/Linear Scaler Assembly 23042-1	Rear
16.	Schematic - Circuit Card A5	Rear
17.	Component Location - Circuit Card A6 Sweep Integrator Assembly 23028-1	Rear
18.	Schematic - Circuit Card A6	Rear
19.	Component Location - Circuit Card A7 Low Frequency Switching Assembly 23034-1	Rear
20.	Schematic - Circuit Card A7	Rear
21.	Component Location - Circuit Card A8 Sine Shaper Assembly 23020-1	Rear
22.	Schematic - Circuit Card A8	Rear
23.	Component Location - Circuit Card A9 Log Converter Assembly 23038-1	Rear
24.	Schematic - Circuit Card A9	Rear
25.	Component Location - Circuit Card A10 Relay Switching Assembly 23044-1	Rear
26.	Schematic - Circuit Card A10	Rear
27.	Component Location - Circuit Card A11 Chopper Driver & Output Amplifier Assy. 23050-1	Rear
28.	Schematic - Circuit Card A11	Rear
29.	Component Location - Circuit Card A12 Power Supply Assembly 23036-1	Rear
30.	Schematic - Circuit Card A12	Rear
31.	Interconnecting Diagram - Model SD104-5	Rear

SECTION I

GENERAL INFORMATION

1.1 SHIPPING AND INSPECTION PROCEDURE

The Model SD104 Sweep Oscillator is shipped fully assembled in a polystyrene case designed to protect the instrument against all normal shipping hazards. Immediately upon receipt, it is recommended that an inspection be made of the exterior of the shipping case, making note of any visible damage. Retain all forms and invoices attached to the carton and upon removal of the instrument from the case, again note any apparent visible damage.

1.2 CLAIM FOR DAMAGE IN SHIPMENT

The instrument should be tested for functional operational as soon as it is received by following the procedure outlined in Section II. If damage in shipment is apparent, a claim should be filed with the carrier. A full report of the damage should be obtained by the claim agent, and this report forwarded to Spectral Dynamics Corporation. The buyer will be advised of the disposition to be made of the equipment and arrangements shall be made for repair or replacement. Include name, model number and serial number when referring to the instrument for any reason.

1.3 WARRANTY

Spectral Dynamics Corporation warrants each instrument manufactured by them to be free from defects in material and workmanship for one year after delivery to the original purchaser. Liability under this warranty is limited to servicing and adjusting the instrument returned to the factory with transportation charges prepaid by the purchaser. This warranty specifically excludes any liability in regard to transistors, fuses and lamps. If the malfunction or a portion thereof is determined by Spectral Dynamics Corporation to have been caused by misuse or abnormal conditions of operation, an estimate will be submitted to the purchaser prior to commencing repairs.

If any malfunction develops, notify Spectral Dynamics Corporation or its representative in your area, giving details of the problem, including name, model and serial number of the equipment. Upon receipt of this information, service data or shipping instructions will be provided.

1.4 RETURN SHIPMENT PROCEDURE

On receipt of shipping instructions, forward the instrument prepaid via Air Freight to the factory or authorized repair station indicated on the instructions. For shipment, the instrument should be replaced in its original shipping case or in a strong exterior container surrounded by two or three inches of shock absorbing material.

1.5 SPECIFICATIONS (Model SD104-5)

This instrument has been carefully calibrated and inspected prior to shipment, according to the following specifications:

Frequency

Range: 0.005 cps to 50 kcps in five ranges as follows:

0.005 cps	to	5 cps
0.05 cps	to	50 cps
0.5 cps	to	500 cps
5.0 cps	to	5000 cps
50.0 cps	to	50 kcps

Stability: 0.05% of full range or 1% of frequency (whichever is smaller) for a period of 8 hours.

Sweep Limits: An upper and lower frequency limit can be preset electronically from the front panel. The upper frequency limit can be set anywhere in the upper decade of each range. The lower frequency limit can be set anywhere in the lower two decades of each range.

Sweep Accuracy: Upper Limit - 0.5% of reading.
Lower Limit - 0.5% of reading, plus or minus .02% of full range.

Display: Front panel meter with automatic range selection. Any single decade of the 3 decade ranges is displayed automatically in conjunction with indicator lights located above the meter.

Display Accuracy: Plus or minus 1% of reading for upper decade range.
Plus or minus 2% of reading for middle and lowest decade range.

Outputs

Available at BNC connectors on rear of chassis.
Impedance: 600 ohms or less.

(J16) Sine Wave (constant amplitude)

- Amplitude: 1 volt rms (approx.)
- Response: Plus or minus 0.1 db, .005 cps to 50 kcps
- Distortion: Less than 0.5%, .005 cps to 5 kcps
  Less than 1.0%, 50 cps to 50 kcps range

(J17) Square Wave (constant amplitude)

- Amplitude: 5 volts p-p (approx.)
- Response: Plus or minus 0.02 db, .005 cps to 50 kcps
- Rise & Fall Time: Less than ~~300~~ 500 nanoseconds

Outputs (Cont'd)

(J18) Triangle Wave (constant amplitude)
- Amplitude: 5 volts p-p (approx.)
- Response: Plus or minus 0.25 db, .005 cps to 5 kcps
  Plus or minus 0.50 db, 5 kcps to 50 kcps

(J22) Sine, Square or Triangle Wave (variable amplitude)
- Selection: Front panel control.
- Amplitude: Adjustable over a 50 db range from 10 volts p-p
- Response: Same as constant amplitude response
- Offset: Adjustable, plus or minus 2.5 volts dc

(J21) Positive dc voltage proportional to log frequency
- Amplitude: 1 volt dc full range (approx.)
- Accuracy: Plus or minus 0.25 db

(J19)
(J20) Positive & negative dc voltage proportional to linear frequency
- Amplitude: Plus and minus 10 volts dc full range
- Linearity: Plus or minus 0.1% of full range, .005 cps to 5 kcps
- Best zero-based straight line: Plus or minus 0.25% of full range, 5 kcps to 50 kcps

(J24) Sweep Sync
- Amplitude: Positive 3 volts pulse, minimum
- Pulsewidth: Approximately 0.5 milliseconds

The sweep sync pulse is generated at the beginning of each sweep and at each point where direction of sweep changes.

Sweep Modes

(1) Linear or logarithmic sweep rates with single or repetitive sweeps.

(2) External - Can be driven from an external positive signal source for programming. Input impedance is 100k ohms. Positive 10 volts full range sensitivity. Can be used in this mode to convert linear dc voltage to log dc voltage.

(3) Manual - The coarse and vernier frequency adjustments combine to provide ease of precise frequency setting.

(4) Hold - Provides a short term stop of the sweep at any desired frequency.

(5) Reset - Can be reset to either upper or lower limit for starting sweeps. Time of reset is 3 seconds (approx.).

1.5 SPECIFICATIONS (Cont'd)

Sweep Rates

(1) Logarithmic - 0.04 decades/ minute in 24 fixed steps for each 3-decade y range.
Accuracy: minus 2% of setting.

(2) Linear - 24 ep speeds for each 3-decade frequency range. S ds vary from .001 cps/sec to 2000 cps/sec depend quency range selected.
Acc Plus or minus 1% of setting.

See Variable Sweep Modification

Power: 115/230 volts ac, 50/60 cycles at approximately 20 watts.

Size: 5.25" x 19" x 15"

Shipping Weight: 25 lbs. (approx.)

1.6 GENERAL DESCRIPTION

The instrument is mounted on a 5-1/4" x 19" standard panel, and a chassis that extends 14" behind the front panel. All the modular type printed circuit card assemblies are easily accessible from the top of the chassis with the top cover removed.

With the exception of A10, Relay Switching Assembly 23044-1, each printed circuit card assembly is individually keyed to match a corresponding nylon key insert in a chassis mounted female receptacle. Particular care should be exercised to ensure that assemblies A1 thru A9 and A11 thru A12 are NOT inserted in the space provided for A10 at any time.

Although the printed circuit card assemblies currently in use number from A1 through A12, provision has been made for future circuit card assembly design in spaces labelled A13 through A15. A connector has been installed in A15 as convenience housing for Circuit Card Extension Assembly 23060-1, when not in use.

Always disconnect the instrument from the power line when inserting or removing printed circuit card assemblies.

SECTION II

OPERATION

2.1 GENERAL

The front panel main function switch is color coded and arranged according to four basic modes of operation; (1) MANUAL, (2) EXTERNAL, (3) LINEAR SWEEP, and (4) LOG SWEEP. All outputs are available at all times in any of the sweep modes. The dc proportional to log frequency is available in all modes including the linear and logarithmic sweep modes.

> Before applying power to the instrument, set the meter mechanical zero adjust screw so that the pointer is resting exactly on 5.

The power on-off switch for the instrument is the extreme counter-clockwise position of the LEVEL control. When this control is rotated clockwise to the first detent position, there will be a time delay of approximately 20 seconds before any indication is noticed on the front panel frequency meter. This is a normal time delay feature designed to protect the instrument against current surges.

2.2 FREQUENCY METER & MULTIPLIER (A) SWITCH

The frequency meter, in conjunction with the MULTIPLIER (A) switch and the decade indicator lights located above the meter, provides a reading of the actual frequency being produced by the SD104. To illustrate, assume that the MULTIPLIER (A) switch is in the 1 position. When the decade indicator light to the far left is on, the meter scale covers a range of 5 to 50 cps. When the middle decade indicator light is on, the meter scale covers a range of 50 to 500 cps. When the decade indicator light to the far right is on, the meter scale covers a range of 500 to 5000 cps. This automatic switching action is in the meter circuitry ONLY and in no way affects the internal operation of the instrument or any of its outputs. Hysteresis has been built into the meter switching to facilitate the setting of any frequency at the extremes of the calibrated dial.

Five multiples of the three basic ranges are obtainable by rotating the MULTIPLIER (A) switch and multiplying the meter reading by the position selected.

Example: The meter indicates 25; the middle decade light is on; MULTIPLIER (A) switch is in the .01 position.

The frequency is: 250 x .01 = 2.5 cps

Example: The meter indicates 25; the decade light to the far right is on; MULTIPLIER (A) switch is in the 10 position.

The frequency is: 2500 x 10 = 25,000 cps

2.3 FREQUENCY ADJUST & VERNIER CONTROLS

The FREQ ADJ and VERNIER controls set the operating frequency of the SD104 when in the MAN. position of the Sweep Mode Selector. The FREQ ADJ control

by itself will normally have sufficient resolution. The VERNIER control, with 10 times greater resolution, will be useful in setting the SD104 to a particular frequency.

2.4 FUNCTION SELECTOR SWITCH

A FUNCTION selector switch is located in the upper right hand corner of the front panel and its position determines the type of output (triangle, sine or square wave) available at the front panel OUTPUT terminals and at J22, BNC rear chassis connector.

2.5 LEVEL CONTROL

The amplitude of the output at the front panel output terminals and at J22, BNC rear chassis connector, is determined by the setting of the LEVEL control, within the range of 30 millivolts to approximately 10 volts peak-to-peak. The extreme counter-clockwise position of the LEVEL control is the on-off power switch for the instrument.

2.6 SWEEP RATE AND MULTIPLIER (B) SWITCH

When sweeping logarithmically as a sweep oscillator, the sweep speed, in decades/minute, is determined by the s[ ] the SWEEP RATE selector multiplied by the setting of MULTIPL[ ]either 1 or 0.1). The inner scale, which is color coded to matc[ ]n function switch (LOG SWEEP), is used.

See Variable Sweep Modification

Example: To sweep [ ]ically at a rate of 0.06 decades/min., set SWE[ ]E at 0.6 (inner scale) and set MULTIPLIER (B) at 0.[ ]weep mode switch in LOG SWEEP positions).

When sweeping linearly, the sweep speed in cps/sec. is determined by the SWEEP RATE selector multiplied by MULTIPLIER (B) and MULTIPLIER (A). The outer scale, which is color coded to match the main function switch (LINEAR SWEEP positions), is used.

See Variable Sweep Modification

Example: To sweep linearly [ ]of 0.75 cps/sec. with the MULTIPLIER (A[ ]et at 0.1 (total range 0.5 - 500 cps), set [ ]ATE at 75 (outer scale) and MULTIPLI[ ]. 1. (Sweep mode switch in LINEAR [ ]sitions).

Solutio[ ] (.1) (.1) = 0.75

2.7 SWEEP MODE SWITCH & PUSHBUTTONS

The following is a detailed explanation of the various positions of the Sweep Mode Switch and use of the pushbuttons.

MANUAL MODE

In the MAN. mode the SD104 acts as a variable frequency oscillator. After setting MULTIPLIER (A) to the desired frequency range, any frequency within that range may be obtained by turning the FREQ ADJ control, utilizing the VERNIER control when necessary for greater resolution. Both the FREQ

ADJ and VERNIER will have to be turned fully counter-clockwise to obtain the lowest frequency in any given range.

Example: To obtain 100 cps in the MAN. mode:

1. Set sweep mode switch to MAN.
2. Set MULTIPLIER (A) to 1 (5 cps to 5000 cps)
3. By means of the FREQ ADJ control, obtain a reading of 10 on the frequency meter with the middle decade light on.

EXTERNAL MODE

In the EXT mode the SD104 acts as a Voltage Controlled Oscillator (VCO) controlled by the dc voltage applied to J23 on the rear of the chassis. This dc voltage should be limited to the range of 10 millivolts to 10 volts. The frequency meter, in conjunction with the setting of the MULTIPLIER (A) switch, will indicate the VCO frequency. All of the SD104 outputs are functioning and in this mode the instrument may be used as a highly accurate dc log converter. The dc output at J21 will be proportional to the log of the applied dc voltage, plus or minus 0.25 db.

UPPER AND LOWER LIMIT ADJUSTMENTS

When operating the SD104 as a Sweep Oscillator, the upper and lower frequency limits can be set from the front panel. This is accomplished by first setting the mode selector switch to the particular type of sweep desired. To set the lower limit, push the RESET DOWN pushbutton and turn the adjacent screwdriver adjustment until the desired frequency is indicated on the meter. To set the upper limit, push the RESET UP pushbutton and turn the adjacent screwdriver adjustment to the desired frequency as shown on the meter. When switching from LOG SWEEP to LINEAR SWEEP or vice versa, the lower limit must be reset.

SINGLE SWEEP MODE (LOG OR LINEAR)

In this mode the SD104 will sweep once, either from the lower limit to the upper limit or vice versa.

Example: To sweep once from the lower limit to the upper limit, set the sweep mode switch to SINGLE (log or linear) and push the RESET DOWN pushbutton. It will automatically reset to the preset lower frequency limit. When the lower limit is reached, as indicated by the frequency meter, push the SWEEP UP pushbutton, actuating a single "up" sweep. When the upper limit is reached, the sweep will stop and the RESET UP light will turn on.

Example: To sweep once from the upper limit to the lower limit, set the sweep mode switch to SINGLE (log or linear) and push the RESET UP pushbutton. It will automatically reset to the preset upper limit. When the upper limit is reached, as indicated by the frequency meter, push the SWEEP DOWN

pushbutton, actuating a single "down" sweep. When the lower limit is reached, the sweep will stop and the RESET DOWN light will turn on.

AUTO SWEEP MODE (LOG OR LINEAR)

In this mode the SD104 will sweep repetitively between the upper and lower limits. This repetitive sweeping may be initiated from either the upper or the lower limit in the same manner as in the single sweep mode. A minimum frequency difference between the upper and lower limits of 3% of full range must be maintained. In addition, the lower limit must always be set at a lower frequency than the upper limit, otherwise the relay logic may "lock-up".

HOLD ADJUST MODE (LOG OR LINEAR)

When in the HOLD ADJ mode the SWEEP UP AND SWEEP DOWN pushbuttons may be used like "elevator" controls. The SD104 will sweep up as long as the SWEEP UP button is depressed, and will stop as soon as the pushbutton is released. This action is identical for SWEEP DOWN. To place the SD104 in the hold adjust mode, push the HOLD pushbutton when operating in either single or automatic sweep. Then turn the Sweep Mode Selector to the HOLD ADJ position.

HOLD FUNCTION

To stop any single or automatic sweep, depress the HOLD pushbutton. The SD104 will remain in HOLD until another button is depressed or the Sweep Mode Switch is moved, and at the frequency that existed just before the HOLD button was depressed. A slight amount of drift in this mode is normal.

2.8 TYPICAL OPERATION

A single linear sweep from 0.2 cps up to 12 cps with a sweep rate of 1cps/sec is desired. Therefore, set MULTIP[illegible]R (A) at .01 (.05 - 50 cps), MULTIPLIER (B) at 1.0 and SWEEP RAT[illegible]0 cps/sec.

The sweep rate is: (.01[illegible] 1 cps/sec

Set Sweep Mode Switch to S[illegible]ear sweep). Depress the RESET UP pushbutton and adjust for a re[illegible] in the highest decade (1200 x .01 = 12 cps). Depress the RESET DO[illegible]utton and adjust for a reading of 20 in the lowest decade (20 x .01 = .2 c[illegible] initiate the single "up" sweep, push the SWEEP UP pushbutton. The tota[illegible]e required for the sweep will be:

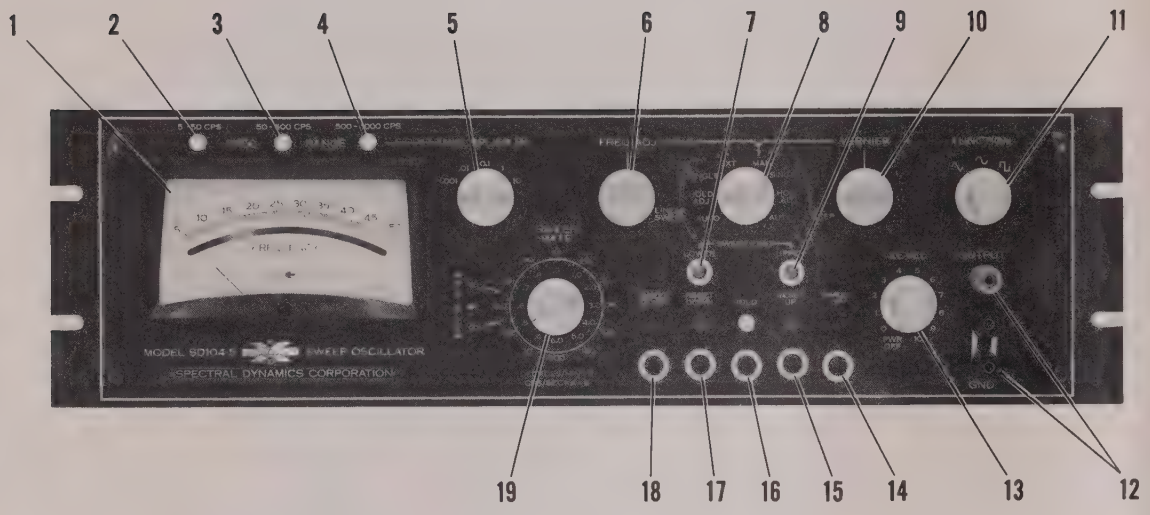
See Variable Sweep Modification

$$\text{Sweep time} = \frac{\text{frequency difference}}{\text{sweep rate}} \quad \text{or} \quad \frac{12 - .2}{1} = 11.8 \text{ seconds}$$

2.9 SWEEP RATE CONVERSION

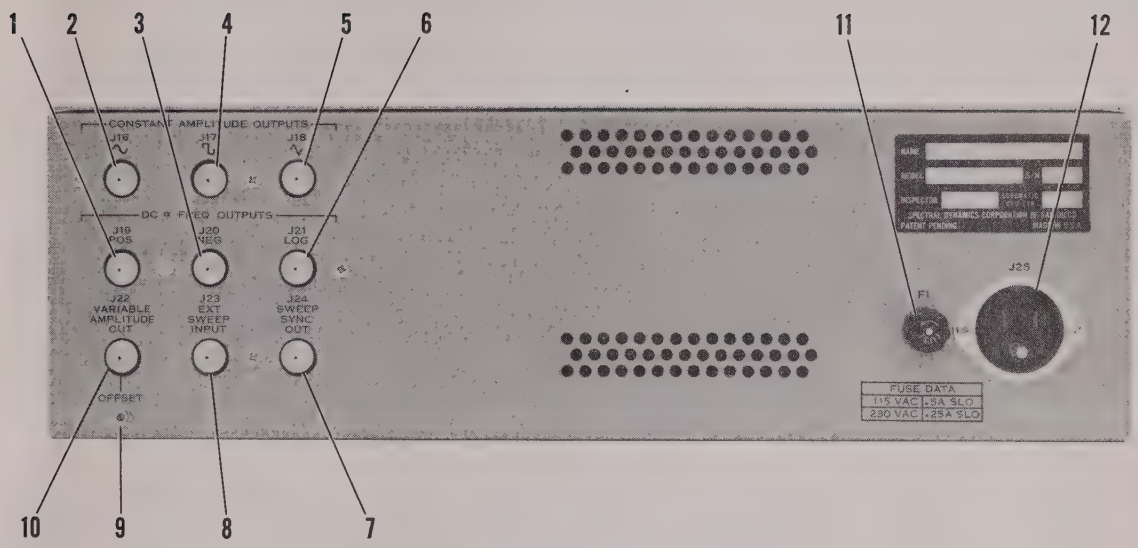
The following table converts the decades-per-minute sweep rate of the Model SD104-5 to its equivalent in degrees per minute as related to the tuning dial commonly used on Bruel & Kjaer Automatic Vibration Exciter Controllers.

DECADES PER MINUTE	DEGREES PER MINUTE
.04	2.88
.05	3.60
.06	4.32
.07	5.04
.08	5.76
.09	6.48
.1	7.2
.2	14.4
.3	21.6
.4	28.8
.5	36.0
.6	43.2
.7	50.4
.8	57.6
.9	64.8
1.0	72.0
2.0	144.0
3.0	216.0
4.0	288.0
5.0	360.0
6.0	432.0



1 FREQUENCY METER M1
2 DECADE INDICATOR LIGHT (5 - 50 CPS)
3 DECADE INDICATOR LIGHT (50 - 500 CPS)
4 DECADE INDICATOR LIGHT (500 - 5000 CPS)
5 MULTIPLIER (A) SWITCH S1
6 FREQUENCY ADJUST R36
7 LOWER LIMIT ADJUST R29
8 SWEEP MODE SWITCH S2
9 UPPER LIMIT ADJUST R33
10 VERNIER ADJUST R2
11 FUNCTION SELECTOR S7
12 OUTPUT/GND TERMINALS
13 OUTPUT LEVEL ADJUST & ON-OFF SWITCH R2/S11
14 SWEEP UP PUSHBUTTON S9
15 RESET UP PUSHBUTTON S8
16 HOLD PUSHBUTTON S5
17 RESET DOWN PUSHBUTTON S6
18 SWEEP DOWN PUSHBUTTON S10
19 SWEEP RATE & MULTIPLIER (B) SWITCH S3/S4

Figure 1. Front Panel View - Model SD104-5



1 POSITIVE DC PROPORTIONAL TO FREQUENCY OUTPUT J19
2 SINE WAVE OUTPUT (CONSTANT AMPLITUDE) J16
3 NEGATIVE DC PROPORTIONAL TO FREQUENCY OUTPUT J20
4 SQUARE WAVE OUTPUT (CONSTANT AMPLITUDE) J17
5 TRIANGLE WAVE OUTPUT (CONSTANT AMPLITUDE) J18
6 LOG DC PROPORTIONAL TO FREQUENCY OUTPUT J21
7 SWEEP SYNC OUTPUT J24
8 EXTERNAL SWEEP INPUT J23
9 OFFSET ADJUSTMENT R31
10 SINE, SQUARE OR TRIANGLE WAVE OUTPUT (VARIABLE AMP.) J22
11 FUSE F1
12 POWER INPUT J25

Figure 2. Rear Chassis View - Model SD104-5

SECTION III

THEORY OF OPERATION

3.1 INTRODUCTION

The theory of operation for the SD104 Sweep Oscillator can be divided into two basic functions: (1) a precision Voltage Controlled Oscillator (VCO), and (2) a Sweep Generator that drives the VCO. For the following discussion refer to the Simplified Block Diagram, Figure 3, which shows a Model SD104 sweeping in the Automatic Linear Sweep Mode.

3.2 SWEEP GENERATOR

Amplifier #1 is an Operational Integrator which produces a ramp voltage. The slope of the ramp it produces is determined by a series resistor selected by the Sweep Rate Switch, and the voltage from MULTIPLIER (B) through K4. To select a fast sweep a low value resistor is chosen by the Sweep Rate Switch, and for a slow sweep a high value resistor is chosen. The voltage supplied by K4 to the Integrator is reduced to 1/10th its original value when MULTIPLIER (B) is in the 0.1 position, thereby providing even slower sweep speeds.

Assuming that K4 is not energized, a negative voltage is supplied to the series resistor selected by the Sweep Rate Switch, causing a positive going ramp at point A. Amplifiers #2 and #3 are Inverter Amplifiers with a gain of 1. The Upper Level Switch is a voltage comparator that generates a pulse when the voltage at point C exceeds the voltage from the Upper Limit Adjust potentiometer. When this occurs, the bistable multivibrator changes state, engergizing K4, which in turn supplies a positive voltage to the Integrator, causing the ramp to have a negative going slope and the process repeats itself.

The lower frequency adjust potentiometer voltage is summed into Amplifier #2, creating an offset voltage and determines the lowest voltage (lowest frequency of the VCO) to which the SD104 will sweep.

The negative dc proportional to frequency at point B is available at J20 and drives the Log Converter. The Log Converter produces a positive voltage that is proportional to the logarithm of the negative dc voltage and is proportional to the logarithm of the frequency produced by the SD104. The log voltage is available at J21. The positive dc proportional to frequency at point C drives the VCO and the meter circuitry and is available at J19.

The Meter Switching Circuit selects the correct meter scale resistance and the corresponding decade indicator light as the positive dc proportional to frequency changes. The decade indicator light to the far left will glow between 10 millivolts and 100 millivolts, the middle decade indicator light will glow between 100 millivolts and 1 volt and the decade indicator light to the far right will glow between 1 volt and 10 volts. The additional set of contacts on relay K4 energizes the SWEEP UP and SWEEP DOWN indicator lights.

3.3 VOLTAGE CONTROLLED OSCILLATOR (VCO)

The VCO is a high speed integrator which runs between an upper and lower voltage level to produce a triangle wave. The time constant of this integrator (Amplifier #4) is set by the value of R3 (fixed) and the particular capacitor selected by MULTIPLIER (A) on the front panel. The slope of the triangle wave produced by Amplifier #4 is determined by the time constant selected and the polarity and magnitude of the dc voltage at point D. The Frequency Controlled Switch passes either the positive or the negative dc proportional to frequency, depending on the polarity of the square wave at point F. The Upper Level Switch and the Lower Level Switch are set to trigger at plus and minus 5 volts, respectively.

Assume that the bistable multivibrator is deenergized and the square wave at point F is negative. This negative voltage will cause the Frequency Controlled Switch to pass the negative dc proportional to frequency through R3 to Amplifier #4 and cause a positive going ramp at point E. When this ramp reaches a positive 5 volts, the Upper Level Switch will trigger and energize the bistable multivibrator. The voltage at point F will then be positive and the Frequency Controlled Switch will pass the positive dc proportional to frequency, causing a negative going ramp at point E. When this ramp reaches negative 5 volts, the Lower Level Switch will trigger and deenergize the bistable multivibrator. This process repeats itself, creating a triangle wave at point E. For a fixed setting of MULTIPLIER (A), the frequency of the triangle wave will be directly proportional to the magnitude of the dc supplied by the Sweep Generator.

The square wave at point F and the triangle wave at point E are buffered and available at the rear chassis BNC connectors J17 and J18, respectively.

The triangle wave at point E also drives the Sine Shaper, providing a sine wave of the same frequency as the triangle wave at connector J16.

Amplifier #5 is a Variable Gain, Variable Offset, Constant Output Impedance Amplifier. The front panel function switch permits the selection of a triangle, sine or square wave outputs available at the front panel output terminals or at J22, rear chassis BNC connector.

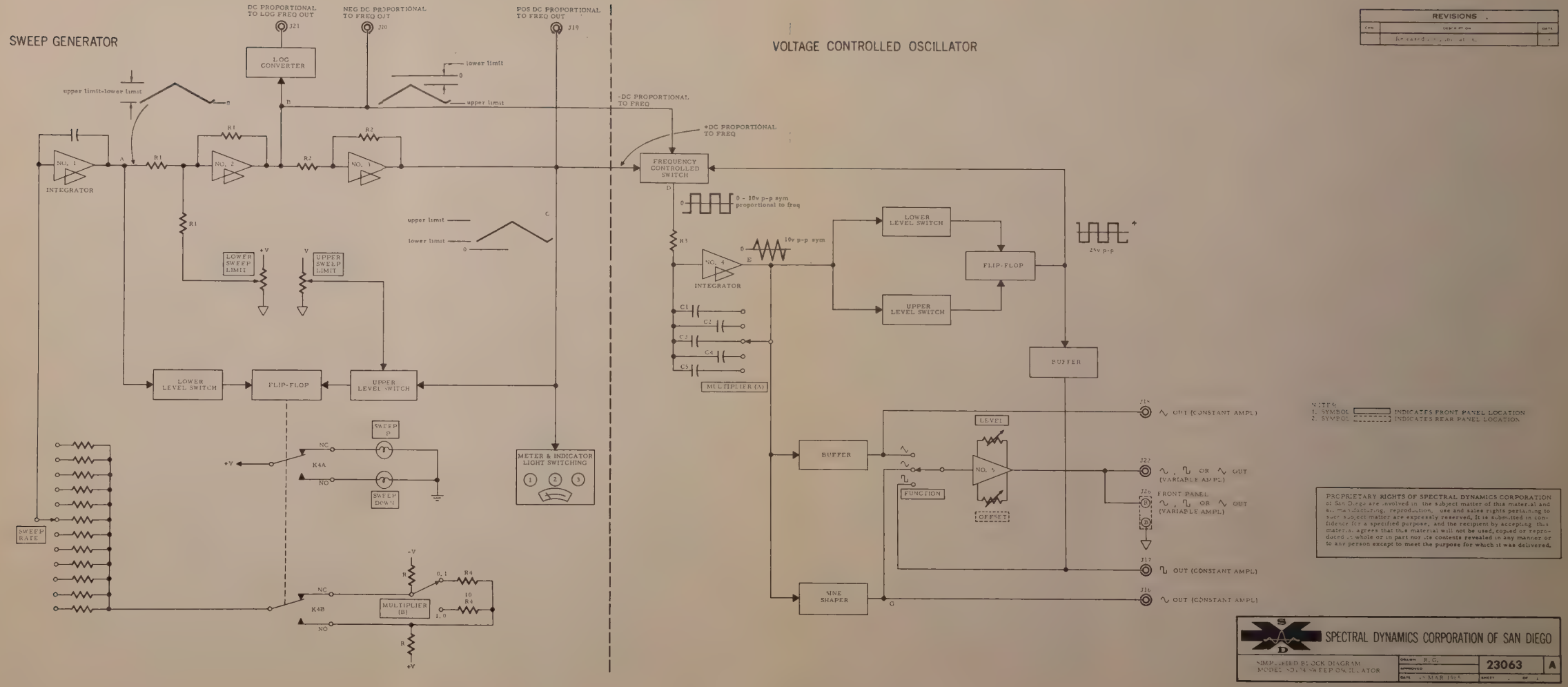


Figure 3. Simplified Block Diagram - Model SD104

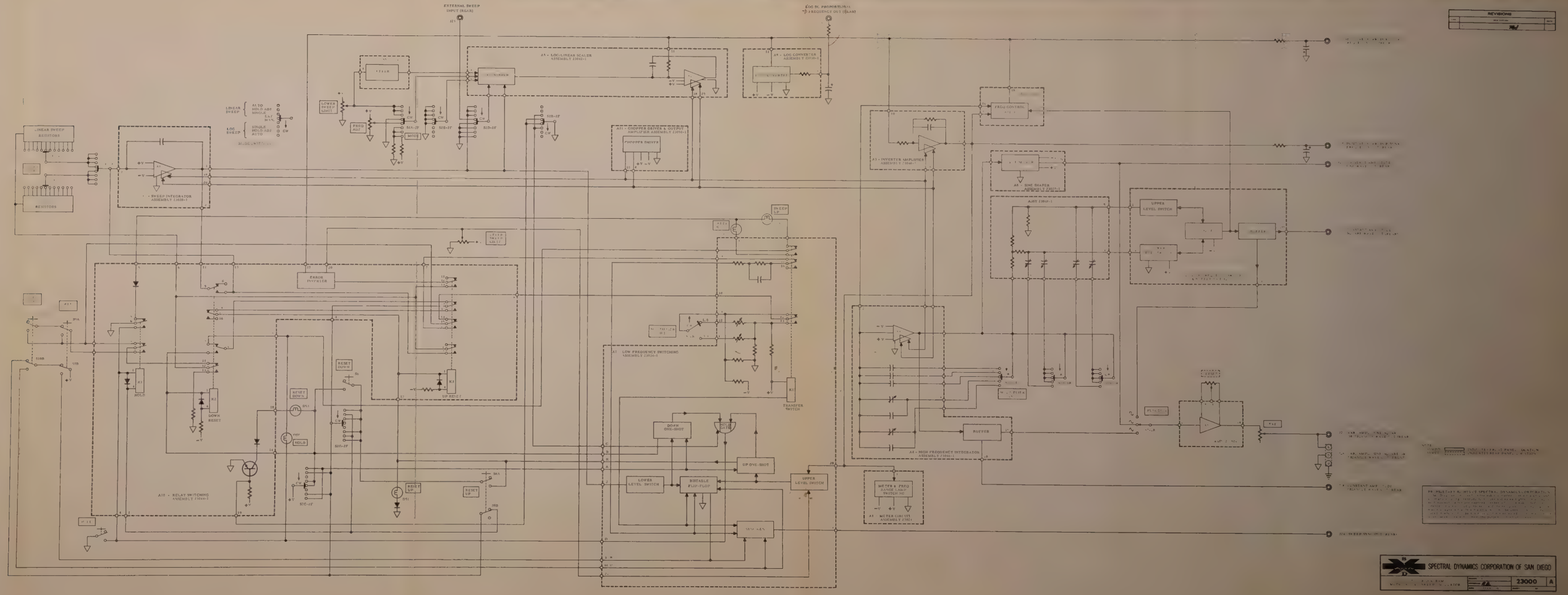

EXTERNAL SWEEP INPUT (RECR)
LOG DC PROPORTIONAL TO FREQUENCY OUT (RAMP)
A5 - LOG/LINEAR SCALER ASSEMBLY 23041-1
A4 - LOG CONVERTER ASSEMBLY 23040-1
A11 - CHOPPER DRIVER AND OUTPUT AMPLIFIER ASSEMBLY 23042-1
CHOPPER DRIVER
A3 - INVERTER AMPLIFIER ASSEMBLY 23046-1
A8 - SINE SHAPER ASSEMBLY 23037-1
A6 - SWEEP INTEGRATOR ASSEMBLY 23038-1
LINEAR SWEEP RESISTORS
LOG SWEEP RESISTORS
A7 - LOW FREQUENCY SWITCHING ASSEMBLY 23024-1
A10 - RELAY SWITCHING ASSEMBLY 23044-1
A4 - HIGH FREQUENCY INTEGRATOR ASSEMBLY 23041-1
A1 - METER CIRCUIT ASSEMBLY 23021-1
A4A1 - 23041-1
FREQ CONTROL
UPPER LEVEL SWITCH
LOWER LEVEL SWITCH
BUFFER
ERROR INVERTER
DOWN ONE-SHOT
UP ONE-SHOT
BISTABLE FLIP-FLOP
TRANSFER SWITCH
METER & FREQ RANGE LAMP SWITCH
REVISIONS
SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO
23000
A

Figure 4. Detailed Block Diagram

SECTION IV

CALIBRATION

4.1 INTRODUCTION

The Model SD104 Sweep Oscillator has been carefully calibrated at the factory. However, after prolonged use or major parts replacement, it may be necessary to recalibrate the instrument according to the procedure contained in this section.

Unless otherwise directed, the digital voltmeter used throughout the following calibration procedure should be grounded to the ground buss common to the nine rear chassis BNC connectors.

Test points and adjustments are referred to by circuit card "A" number throughout the calibration procedure. For example, adjustment of R12 on card A6 will be noted as A6R12; test point 3 on card A6 will be noted as A6TP3, etc. All card receptacles (except A10) have one or two nylon "keys" inserted in line with black dots silk screened on the top side of the chassis, adjacent to the receptacle. The circuit card extension assembly should be used when necessary to gain easy access to test points. To install the extension card, remove the nylon key(s) in the chassis receptacle using a pair of long nose pliers. Replace the key(s) after the card extension is removed.

CAUTION

Always disconnect the ac power cord from the instrument when removing and replacing circuit card assemblies.

4.2 METER

Before applying power to the instrument, set the meter mechanical zero adjust screw so that the pointer of the meter is resting exactly on 5.

4.3 POWER SUPPLY

Apply ac line power to the unit and rotate the front panel LEVEL control clockwise, turning the unit on. With a digital voltmeter connected to A12TP2, adjust A12R16 for negative 15 volts dc. Connect the voltmeter to A12TP3 and adjust A12R8 for positive 15 volts dc.

Using an oscilloscope, measure the ac ripple at A12TP2 and A12 TP3. The ripple should not exceed 1.5 millivolts peak-to-peak, referenced to circuit ground.

4.4 METER CALIBRATION

Mount circuit card A1 on the extension assembly in the A1 receptacle. Set the front panel mode switch to the MAN. position and the FREQ ADJ and VERNIER controls to their extreme counter-clockwise positions. Ground the digital voltmeter directly to some point originating from pin 20 of card A1.

Measure the voltage at A1TP1, which should be a positive 10 millivolts, plus or minus 0.1 millivolt. At A1TP2 it should be 100 millivolts plus or minus 1 millivolt, and at A1TP3 it should be 1 volt, plus or minus 0.01 volt.

Remove circuit card extension assembly and replace circuit card assembly A1.

Connect the digital voltmeter to J19, BNC rear chassis connector, and with the FREQ ADJ and VERNIER controls on the front panel, set the dc-proportional-to-frequency voltage to 9.999 volts. Adjust SHUNT potentiometer A1R33 for a reading of 50 on the front panel frequency meter, with the decade indicator light to the far right (highest decade) illuminated.

Set the dc-proportional-to-frequency voltage to 100 millivolts and adjust SERIES potentiometer A1R34 for a reading of 50 on the front panel frequency meter, with the decade light to the far left (lowest decade) illuminated. If A1R34 has insufficient range to set the meter correctly, turn 2ND DECADE potentiometer A1R21 clockwise or counterclockwise until A1R34 adjusts properly.

Repeat the previous two steps until both conditions are properly met.

Adjust 2ND DECADE potentiometer A1R21 so that the decade indicator lights switch from the lowest decade to the middle decade just as the meter pointer reaches 51 (last marked division), as the FREQ ADJ control is slowly brought through this point in a clockwise direction.

Adjust the 3RD DECADE potentiometer A1R10 so that the decade indicator lights switch from the middle decade to the highest decade just as the meter pointer reaches 51 (last marked division), as the FREQ ADJ control is slowly brought through this point in a clockwise direction.

4.5 CHOPPER DRIVE

Adjust DRIVE potentiometer A11R10 for 3.4 volts peak-to-peak at A11TP3, as measured with an oscilloscope.

4.6 UP RESET SERVO

Mount circuit card A10 on the extension assembly in the A10 receptacle. Place the front panel mode switch in the SINGLE (LINEAR SWEEP) position and depress the RESET UP pushbutton. Connect a digital voltmeter to A10TP1 and rotate the UPPER LIMIT control fully counter-clockwise, noting the reading on the voltmeter. Connect the voltmeter to A10TP2 and adjust OFFSET potentiometer A10R10 for the same reading, but of opposite polarity.

Reconnect the voltmeter to A10TP1 and adjust the UPPER LIMIT control for a reading of approximately 9 volts, and note this reading. Reconnect the voltmeter to A10TP2 and adjust BALANCE potentiometer A10R15 for the same reading, but of opposite polarity. Repeat until the voltage at A10TP1 tracks the voltage at A10TP2 within 2 millivolts.

Remove circuit card extension assembly and replace circuit card assembly A10.

4.7 OFFSET ADJUSTMENT

Set the front panel mode switch to the MAN. position. Connect a digital voltmeter to the center terminal lug (wiper) of the FREQ ADJ potentiometer and rotate both the FREQ ADJ and VERNIER controls as necessary to obtain a reading of 10 millivolts.

Connect the voltmeter to J20 and adjust OFFSET potentiometer A5R17 for negative 10 millivolts.

Connect the voltmeter to J19 and adjust OFFSET potentiometer A3R8 for positive 10 millivolts.

Mount circuit card A6 on the extension assembly in the A6 receptacle. Set the mode switch in the SINGLE (LINEAR SWEEP) position and depress the RESET DOWN pushbutton. Connect the digital voltmeter to A6TP2 and adjust OFFSET potentiometer A6R10 for a reading of zero, plus or minus 0.02 millivolts.

Repeat the preceding adjustments as necessary and recheck the measurements to ensure that the settings of the OFFSET potentiometers are correct.

Remove circuit card extension and replace circuit card assembly A6.

4.8 TRIANGLE WAVE ADJUSTMENT

With the mode switch in the MAN. position, set the FREQ ADJ control for some frequency meter indication with the middle decade indicator light on. Set MULTIPLIER (A) to the .1 position and connect an oscilloscope probe to A4TP2. (Note: The scope must be calibrated and used in the dc coupled mode.) Adjust UPPER potentiometer A2R1 until the upper peak of the triangle wave is exactly 5 volts above ground.

Adjust LOWER potentiometer A2R23 until the negative peak is exactly 5 volts below ground.

4.9 SYMMETRY ADJUSTMENT

Set the mode switch to the MAN. position and both the FREQ ADJ and the VERNIER controls fully counter-clockwise. Turn the LEVEL control fully clockwise. With front panel FUNCTION switch, select the square wave output and set MULTIPLIER (A) in the 10 position. Monitoring the front panel output terminals with an oscilloscope, adjust OFFSET potentiometer A4R2 for time symmetry of the square wave.

4.10 SWEEP ZERO ADJUSTMENT

Connect the X axis of a dc recorder (Moseley 136 or equivalent) to J19 (dc voltage proportional to frequency), BNC rear chassis connector.

Set the mode switch to SINGLE (LINEAR SWEEP). Press the RESET DOWN button. Set the LOWER SWEEP LIMIT for a frequency reading of 5 on the low decade. Press the RESET UP button. Set the UPPER SWEEP LIMIT for a frequency reading of 50 on the high decade.

Adjust the dc recorder to place the pen at the left and right margins when in the DOWN and UP reset modes respectively.

Set the mode switch to AUTO (LINEAR SWEEP) and press the RESET DOWN button. Note the exact position of the recorder when it comes to rest.

Set SWEEP RATE for 30 cps/sec and MULTIPLIER (B) to 1.0. Momentarily press SWEEP UP button. When the plotter pen has moved away from the left margin by an inch or so, momentarily press the SWEEP DOWN button. Note the amount by which the plotter pen undershoots or overshoots the "rest" position of the RESET DOWN mode (see previous paragraph). Repeat the up and down sweeps, adjusting ZERO potentiometer A7R21 for zero overshoot or undershoot.

4.11 SWEEP UPPER LIMIT

With the recorder still connected to J19, push the RESET UP button and note position on recorder. Using the techniques described in paragraph 4.10, adjust TRANSFER potentiometer A7R51 for zero overshoot or undershoot.

4.12 LOG CONVERTER

Disconnect the instrument from the ac power line and remove circuit card assemblies A2, A3, A4 and A5 from the chassis. Connect a 10k ohm resistor from A9TP4 to A9TP3 and attach a jumper wire between A9TP1 and A9TP2. Restore ac power, connect a digital voltmeter to A9TP3 and adjust ZERO potentiometer A9R4 for zero volts, plus or minus 0.02 millivolts.

Connect the voltmeter to A9TP4 and adjust LIN potentiometer A9R13 for zero, plus or minus 0.02 millivolts.

Disconnect the instrument from the ac power line and reinstall circuit card assemblies A2, A3, A4, A5 and A9. Restore the ac power. Place the mode switch in MAN. mode. Connect the dc recorder, with 3 cycle log paper in place, to connector J21. Connect a digital voltmeter to J19 (dc proportional to frequency), and adjust the recorder for full scale operation between 10 millivolts and 10 volts, using FREQ ADJ control on the front panel of the SD104 to vary the dc. Adjust the frequency control so that the recorder is set to the top of the first decade on the 3 cycle paper. The voltmeter should read 100 millivolts, plus or minus 1.5 millivolts.

Adjust the frequency control so that the recorder is set to the second decade point on the 3 cycle paper. The digital voltmeter should read 1 volt, plus or minus 15 millivolts.

Note: The LIN potentiometer A9R13 may have to be readjusted to obtain the above accuracy. If this becomes necessary, adjust the frequency control for a digital voltmeter reading of 100 millivolts. Note the error shown on the plotter. Adjust A9R13 so as to double the error. Reset the plotter end points at the 10 millivolt and 10 volt settings and recheck the linearity as described above. Repeat this procedure as necessary.

4.13 SWEEP TIME

Set the mode switch in the SINGLE (LIN[illegible] "WEEP) position, MULTIPLIER (B) in the 1.0 position and the SWEEP RA[illegible] J0 cps/sec. Adjust the UPPER and LOWER LIMITS for a full 3-dec[illegible] p. The time duration of a single UP sweep should be 25 seconds. If ne[illegible], adjust FAST potentiometer A7R60 for a sweep time of 25 seconds, [illegible] minus 0.25 seconds.

See Variable Sweep Modification

Connect the digital voltmeter [illegible] 7 and note the vol[illegible] ding. Set the MULTIPLIER (B) to the .1 [illegible] and adjust SLOW [illegible] neter A7R61 to exactly 1/10 of the reading [illegible] usly noted.

See Variable Sweep Modification

Set the mode switch in SINGLE (LOG SWEEP), [illegible] LIER (B) in the 1.0 position, SWEEP RATE for 6 dec/min, and th[illegible] and LOWER LIMITS for a full 3-decade sweep. Adjust the LOG GAI[illegible] ometer A5R4 for a sweep duration of 30 seconds, plus or minus 0.3 se[illegible].

4.14 LINEARIZATION

NOTE

The following adjustments should be made with circuit cards A3 and A4 plugged directly into their receptacles. Do not use the extender card assembly. Adjust the capacitors with an offset screwdriver or similar tool.

Set MULTIPLIER (A) to the 0.1 position and the mode switch to MAN. With the voltmeter connected to J19, set the dc-proportional-to-frequency to 100 millivolts. Adjust FREQ potentiometer A2R33 for 5.000 cps (period of 200 milliseconds) at J16, using a frequency counter.

Set MULTIPLIER (A) to the 1 position and adjust A4C5 for 50 cps.

Set MULTIPLIER (A) to the 10 position and adjust A4C6 for 500 cps.

Connect an oscilloscope that has at least a 10 megacycle bandpass (Tektronix 545 or equivalent) to A4TP2 and set MULTIPLIER (A) to the 1 position.

Adjust A3C2 and A3C4 so that the amplitude variation of the triangle wave is minimized over a range of 5 cps to 5000 cps, and the variations in the positive and negative peaks are symmetrical with respect to circuit ground. Make sure that when the front panel meter indicates 5000 cps, that the actual output frequency is 5000 cps, plus 30 cps, minus 0 cps. If necessary, make further adjustment of A3C2 and A3C4.

Set MULTIPLIER (A) to the 10 position. Connect the oscilloscope to A3TP2 and adjust A3C1 and A3C3 so that the amplitude variation of the triangle wave is minimized over a range of 50 cps to 50,000 cps, and the variations in the positive and negative peaks are symmetrical with respect to circuit ground. Make sure that when the front panel meter indicates 50,000 cps, that the actual output frequency is 50,000 cps, plus 200 cps, minus 0 cps. If necessary, make further adjustment of A3C1 and A3C3.

4.15 SINE SHAPER

The adjustment of the Sine Shaper will require a dual trace oscilloscope and a distortion analyzer (HP Model 330D or equivalent). Set the SD104 for 2000 cps, MAN. mode, with the MULTIPLIER (A) switch in the 1 position. Connect the distortion analyzer to J16. With one input of the oscilloscope connected to J16 and the other input connected to the OUTPUT TO OSCILLOSCOPE jack on the distortion analyzer, it can be seen at what points distortion occurs on the sine wave. This distortion can be minimized by the adjustment of the eight break-point potentiometers A8R11, A8R13, A8R19, A8R23, A8R29, A8R33, A8R38 and A8R43, and the symmetry potentiometer A8R3. Total harmonic distortion of less than 0.5% should be obtained.

4.16 OUTPUT AMPLIFIER

Turn the front panel LEVEL control fully clockwise and connect an oscilloscope to the front panel OUTPUT jack. Adjust the BAL potentiometer A11R24 so that the OFFSET control on the rear of the chassis will vary the offset of the sine wave variable output equally in a positive and negative direction.

4.17 HOLD DRIFT

Set the mode switch in the SINGLE (LINEAR SWEEP) position and press the DOWN RESET button. Start an UP sweep and depress the HOLD button while in the lowest decade range. After a period of two minutes, adjust A6R5 for minimum upward drift. Drift should be less than 2 millivolts per minute as measured at J19 using a digital voltmeter.

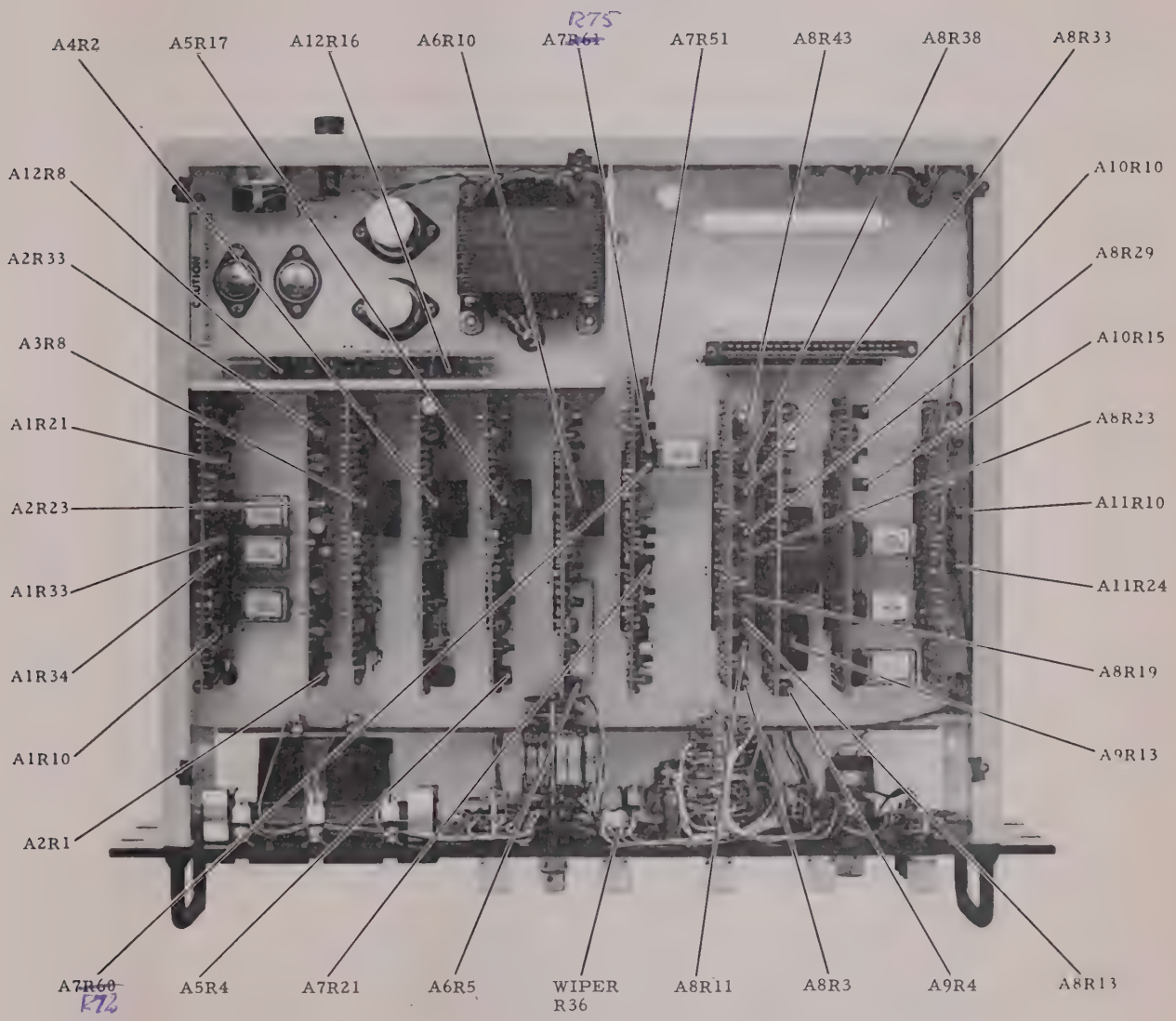


Figure 5. Top View - Model SD104

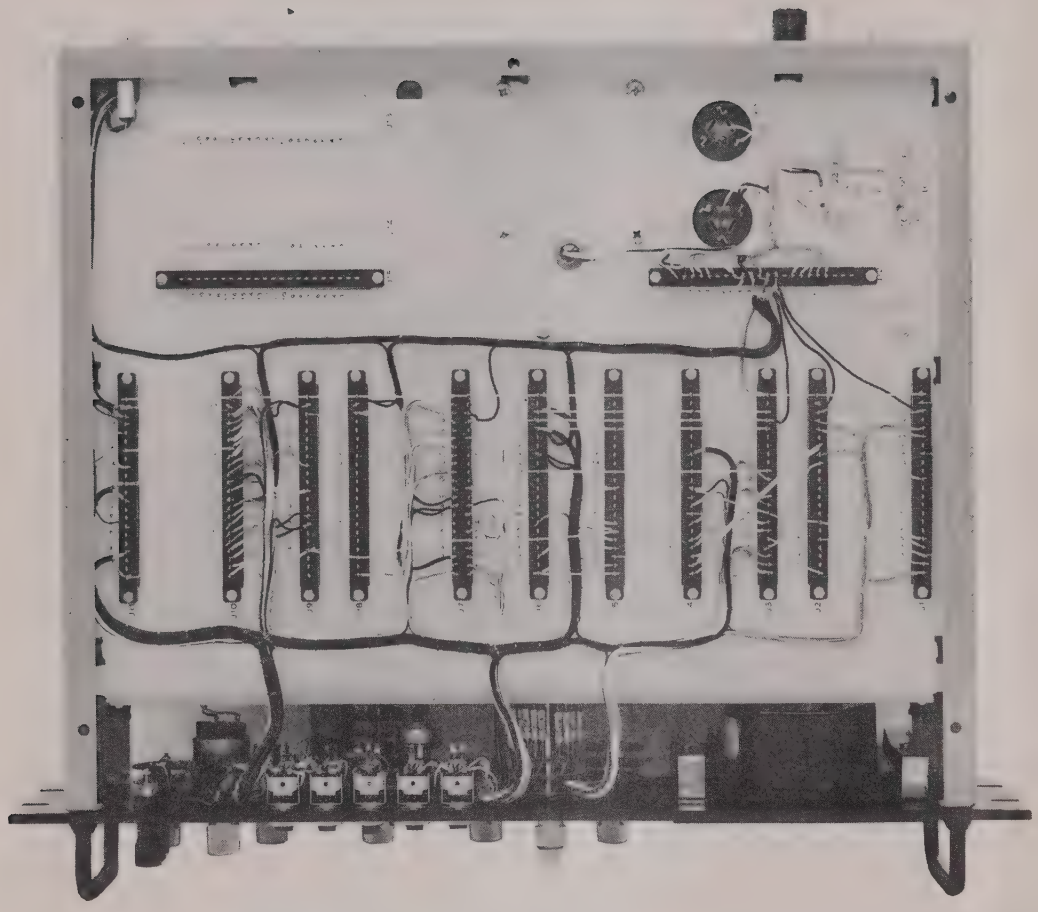


Figure 6. Bottom View - Model SD104-5

SECTION V

REPLACEABLE PARTS

5.1 GENERAL

Standard electronic components have been used in this instrument wherever possible. However, certain design features and innovations call for certain special components in some cases. A complete listing of all the module type printed circuit card assemblies and special components are contained in this section.

Spectral Dynamics Corporation maintains a complete stock of all parts used in this instrument, including complete printed circuit board assemblies. When ordering replacement parts or assemblies, always include, in addition to any assigned stock number information listed below, a complete description of the item being ordered, the reference designation and the model and serial number of the equipment.

5.2 SPECIAL REPLACEABLE PARTS LIST

Reference Designation	Description	Part No. or Mfr. Desig.
A1	Meter Circuit Assembly	23024-1
A2	High Freq. Switch & Buffer Assembly	23022-1
A3	Inverter Amplifier Assembly	23048-1
A4	High Frequency Integrator Assembly	23046-1
A5	Log/Linear Scaler Assembly	23044-1
A6	Sweep Integrator Assembly	23028-1
A7	Low Frequency Switching Assembly	23034-1
A8	Sine Shaper Assembly	23020-1
A9	Log Converter Assembly	23038-1
A10	Relay Switching Assembly	23044-1
A11	Chopper Driver & Output Amp. Assy.	23050-1
A12	Power Supply Assembly	23036-1
A13	(not used)	
A14	(not used)	
A15	Circuit Card Extension Assembly	23060-1
A3A1 A4A1 A5A1 A6A1	Solid State Chopper Assembly (potted)	23026-1
A9A1 A9A2 A9A3	Transistor, (potted) Matched Pair Assembly 23032-1 (2N3391A)	20013-044
A1Q3A & A1Q3B A1Q6A & A1Q6B	Transistor, (cemented) Matched Pair Assembly 23054-1 (2N3391A)	20013-045

5.2 SPECIAL REPLACEABLE PARTS LIST (Cont'd)

Reference Designation	Description	Part No. or Mfr. Desig.
A11A8 & A11A9 A2Q10A & A2Q10B A8Q17A & A8Q17B	Transistor, Matched Pair (2N1304/2N1305)	20013-042
~~A1Q2~~, ~~A1Q5~~, A2Q1, A2Q7, A3Q5, A4Q5, A5Q5, A6Q5, A7Q1, A7Q13, A7Q16, A7Q18, A9Q3, Q9Q6	Transistor, Selected (2N3638)	20013-048
A1Q2, A1Q5	Transistor, Selected (2N3638)	20013-048
M1	Meter, Front Panel	20013-039
S1	Switch, Multiplier (A)	OAK 248634-F2
S2	Switch, Mode Selector	OAK 248635-BF7
~~S3/S4~~	~~Switch, Multiplier (B)/Sweep Rate~~	~~OAK 248637-F4~~
S7	Switch, Function	OAK 248636-F1
T1	Transformer, Power	20013-~~049~~ 060

Figure 7. Component Location - Circuit Card A1
Meter Circuit Assembly 23024-1

Figure 8. Circuit Card A1

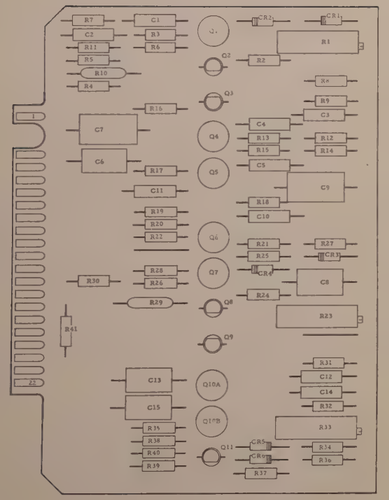
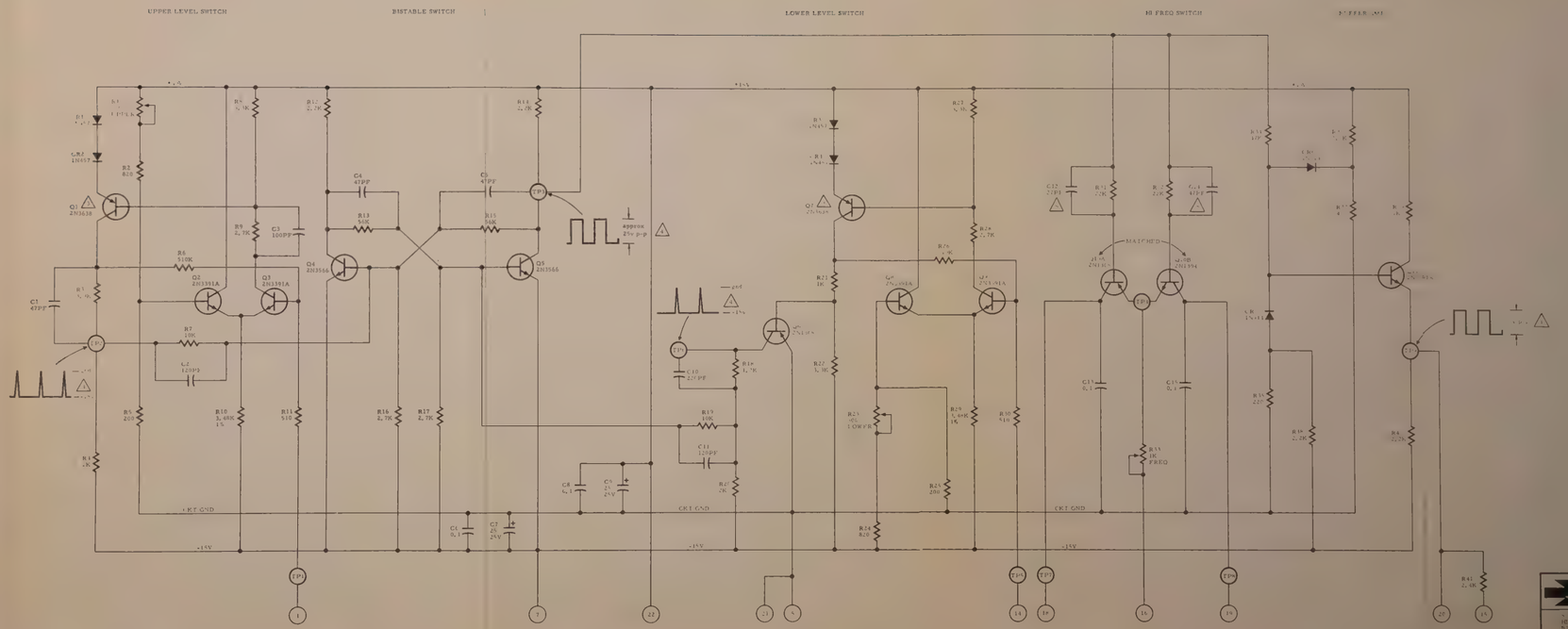


Figure 9. Component Location - Circuit Card A2
High Frequency Switch & Buffer Assembly 23022-1



REVISIONS

LTR	DESCRIPTION	DATE
A	[illegible]	[illegible]
B	[illegible]	[illegible]

NOTES

1. ALL RESISTOR VALUES IN OHMS AND ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATION USED
   ER NO. USED R26, TP7
   ▲ FACTORY SELECTED
   ▲ [illegible]
   ▲ FOR THIS ASSEMBLY ONLY, NOMINAL VALUE SHOWN

THE PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO, CALIFORNIA, INCLUDE THE RIGHTS IN THIS MATERIAL AND WORK THAT ARE CREATED WHILE PERFORMING THE CONTRACT AND ARE NOT GENERALLY KNOWN. ALL RIGHTS ARE EXPRESSLY RESERVED. NO PART OF THIS MATERIAL OR WORK MAY BE REPRODUCED OR USED IN ANY MANNER WHATSOEVER WITHOUT THE PRIOR WRITTEN CONSENT OF SPECTRAL DYNAMICS. IN ADDITION, OWNERSHIP OF THIS MATERIAL AGREES THAT IT WILL NOT BE USED, COPIED OR REPRODUCED IN WHOLE OR IN PART, NOR DISCLOSED TO OTHERS OR USED IN ANY MANNER OR TO ANY PERSON EXCEPT TO MEET THE PURPOSE FOR WHICH IT WAS DELIVERED.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SIZE	DWG. NO.	REV
D	23003	B

SCALE: NONE WEIGHT: SHEET 1 OF 1

Figure 10. Circuit Card A2

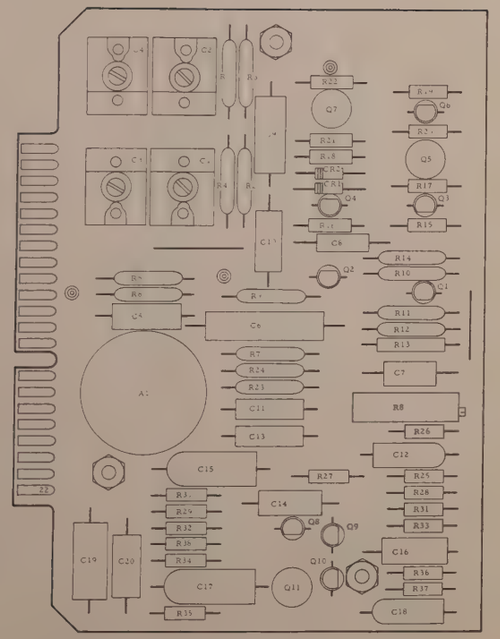
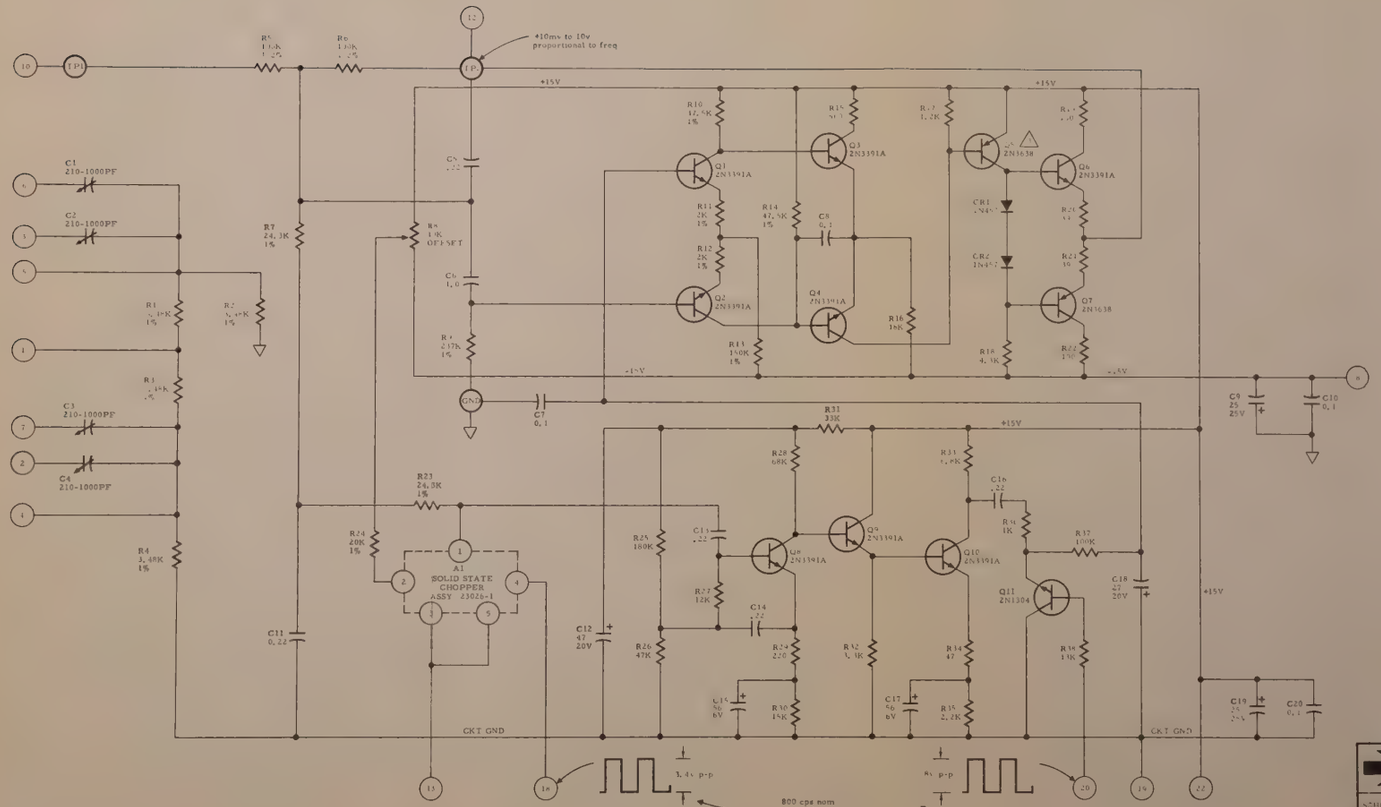


Figure 11. Component Location - Circuit Card A3
Inverter Amplifier Assembly 23048-1

REVISIONS		
ENG	DESCRIPTION	DATE
A	Released for production.	2/65



NOTES:

1. RESISTOR VALUES IN OHMS AND CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   A1 C20 CR2 Q11 R38 TP.
3. △ FACTORY SELECTED

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION of San Diego are involved in the subject matter of this material and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. This submitted as confidence for a specified purpose, and the recipient by accepting this material agrees that this material will not be used, copied, or reproduced in whole or in part nor its contents revealed in any manner or to any person except to meet the purpose for which it was delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEM, P/C
INVERTER AMPLIFIER ASSEMBLY 23048-1

DRAWN	APPROVED	DATE	23004	A
R.		FEB. '65	SHEET 1 OF 1	

Figure 12. Circuit Card A3

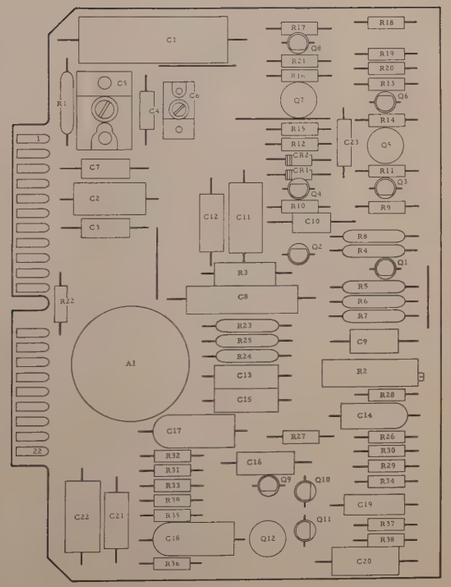
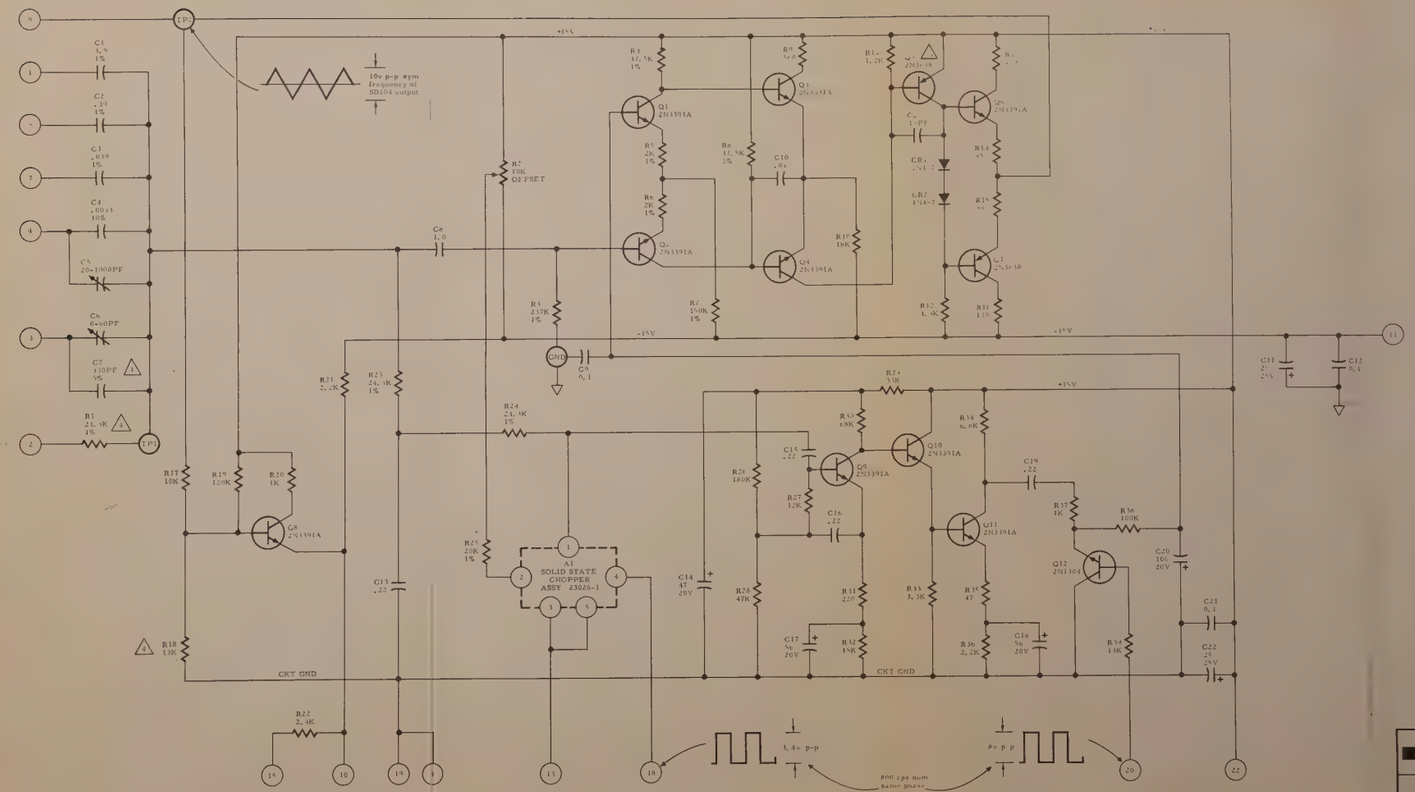


Figure 13. Component Location - Circuit Card A4
High Frequency Integrator Assembly 23046-1



REVISIONS			
LTR	DESCRIPTION	DATE	APPROVED
A	[illegible]	[illegible]	[illegible]
B	[illegible]	[illegible]	[illegible]

NOTES:

1. RESISTOR VALUES IN OHMS AND CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE INDICATED.
2. LAST REFERENCE DESIGNATORS USED:
   A1 C22 CR2 Q12 R38 TP2
3. △ FACTORY SELECTED.
4. ⚠ FACTORY ADJUST WITH NOMINAL VALUE SHOWN.

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION of San Diego are involved in the subject matter of this material and all manufacturing, reproduction, use and sales rights pertaining to such subject matter are expressly reserved. It is submitted in confidence for a specified purpose, and the recipient by accepting this material agrees that this material will not be used, copied or reproduced in whole or in part nor its contents revealed in any manner or to any person except to meet the purpose for which it was delivered.

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC - HIGH FREQ. INTEGRATOR ASSEMBLY 23046-1	DRAWN R.G.	23005	B
	APPROVED		
	DATE 15 FEB 1965	SHEET 1 OF 1	

Figure 14. Circuit Card A4

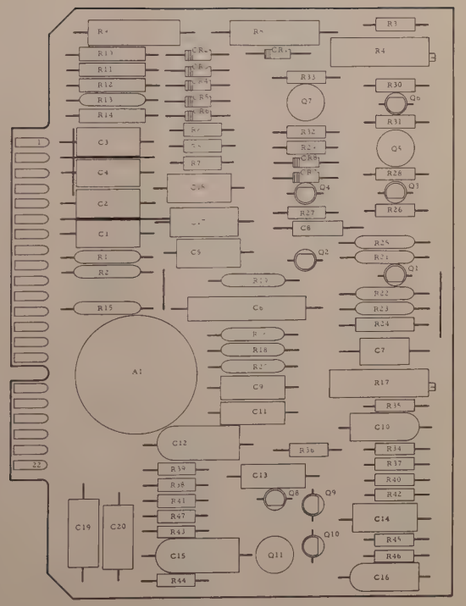


Figure 15. Component Location - Circuit Card A5
Log/ Linear Scaler Assembly 23042-1

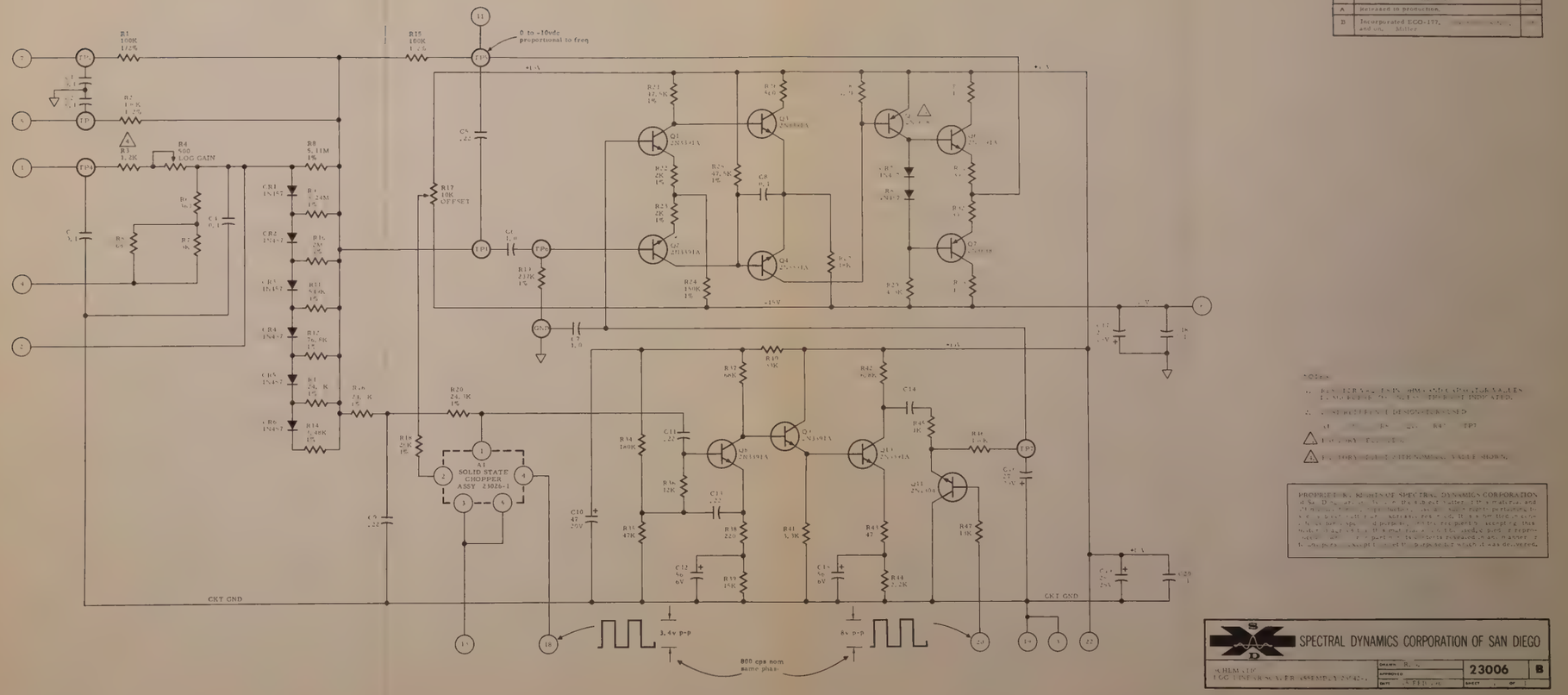


Figure 16. Circuit Card A5

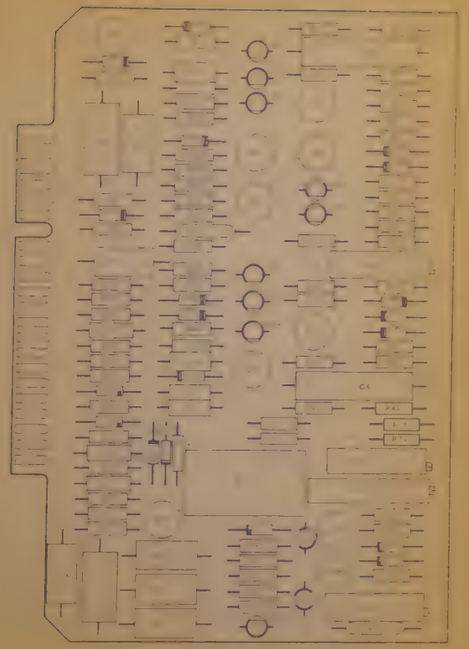
REVISIONS

A	Released to production.	
B	Incorporated ECO-177, [illegible]	

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

23006 B



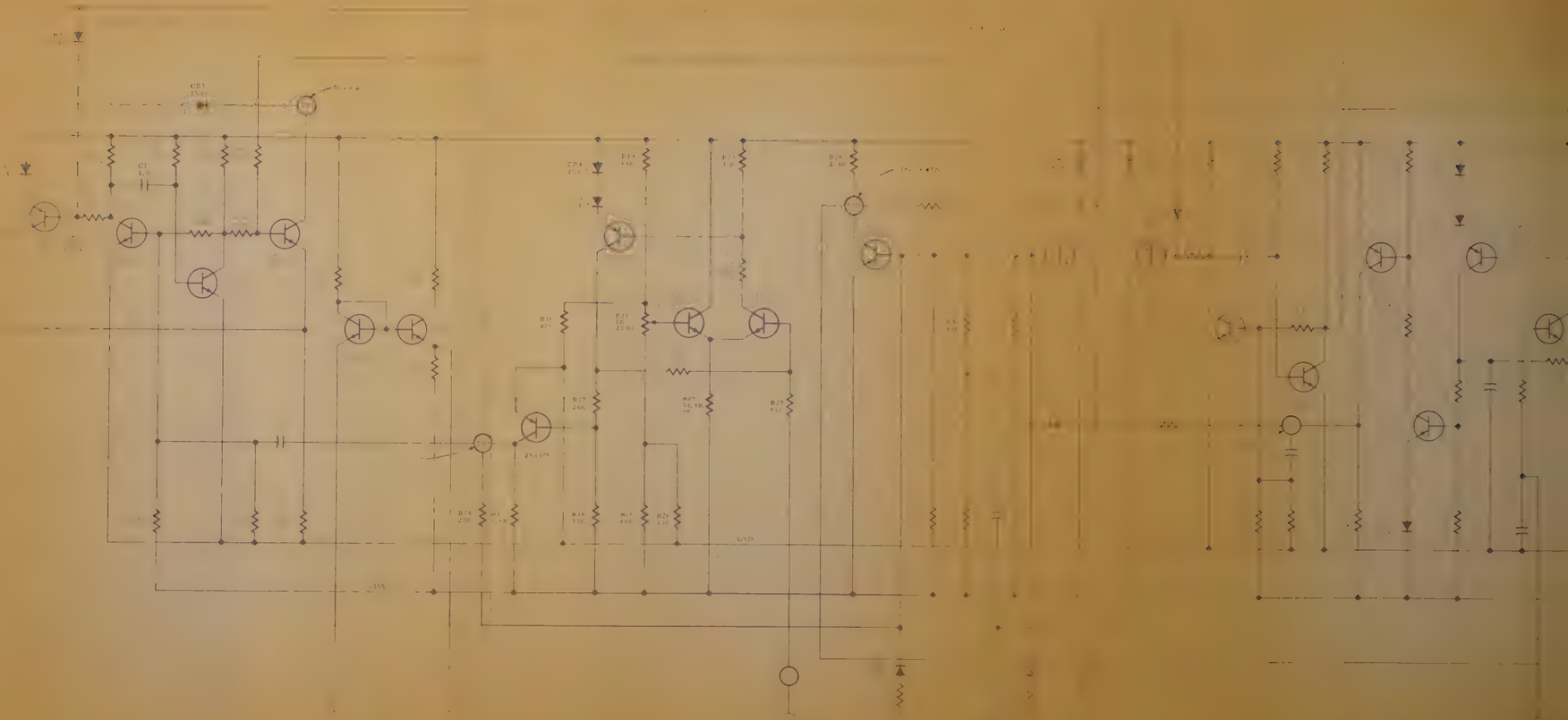


Figure 19. Component Location - Circuit Card A7
Low Frequency Switching Assembly 23034-1

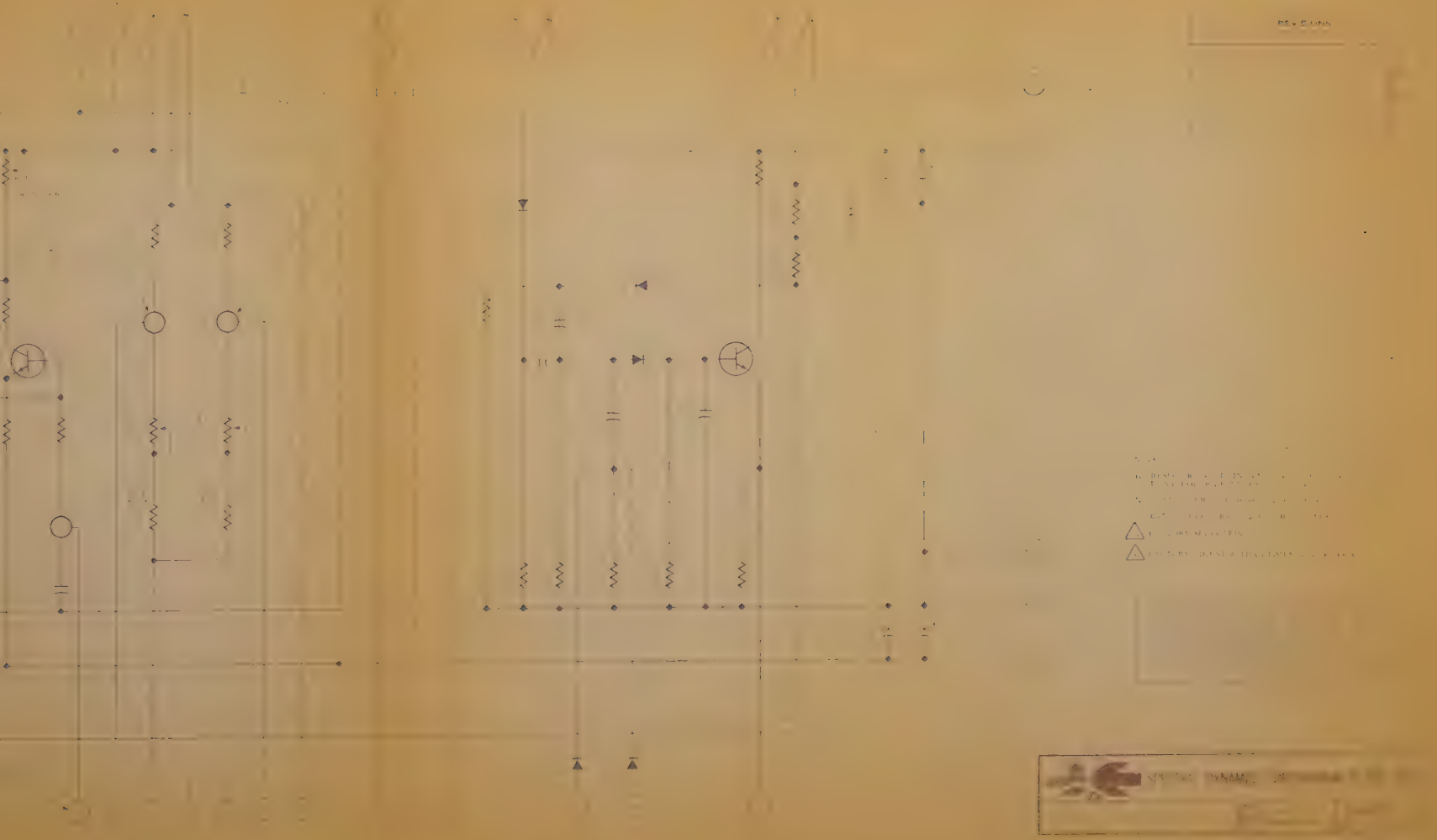


Figure 20. Circuit Card A7

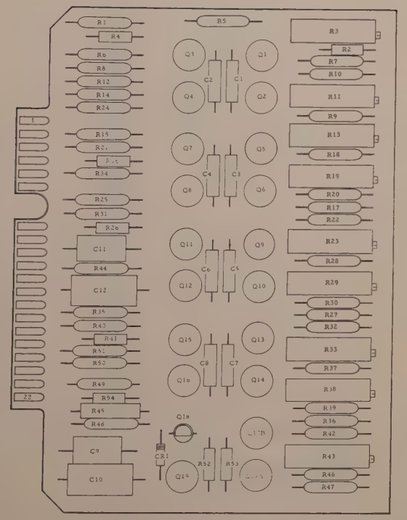
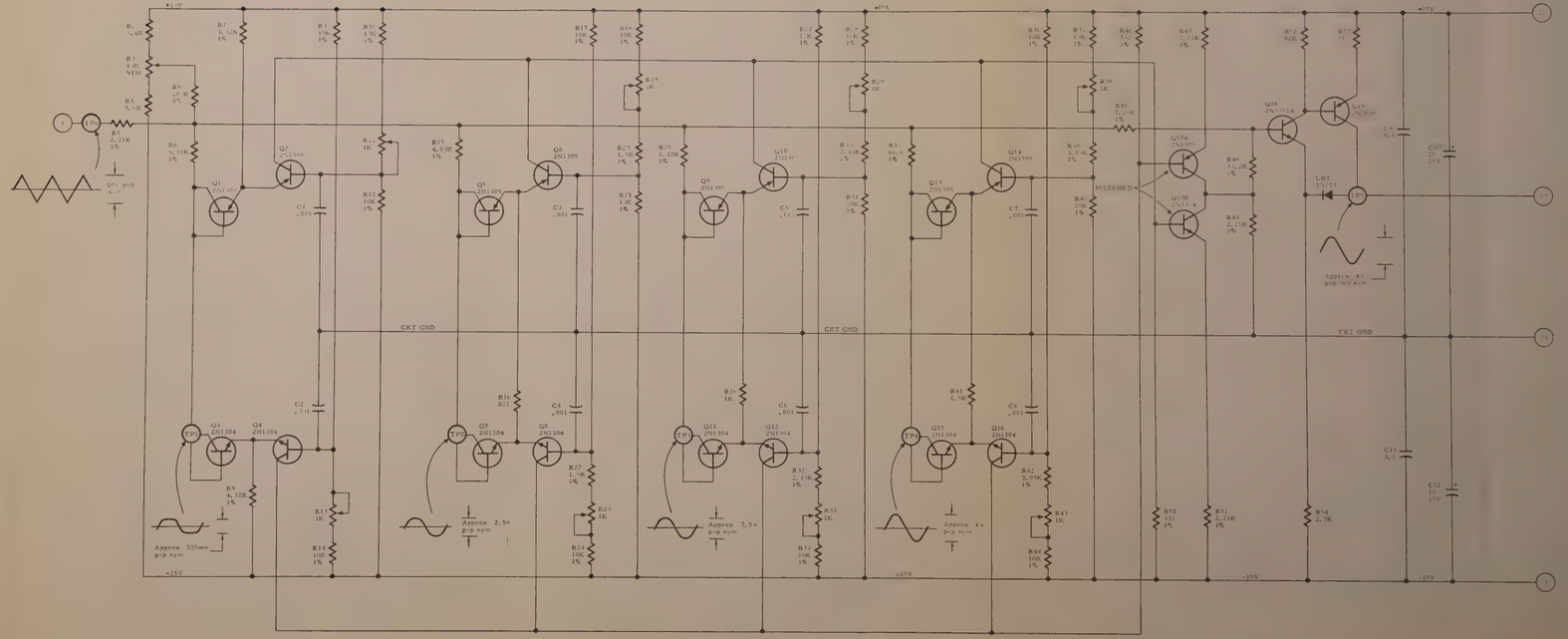


Figure 21. Component Location - Circuit Card A8
Sine Shaper Assembly 23020-1



REVISIONS		
LTR	DESCRIPTION	DATE
A	[illegible]	[illegible]

NOTES

1. ALL RESISTOR VALUES ARE COMMON ANALOG CAPACITOR VALUES ARE IN MICROFARADS UNLESS OTHERWISE NOTED.
2. DASH REFERENCE DESIGNATORS USED.

PROPRIETARY INFORMATION OF SPECTRAL DYNAMICS CORPORATION
[illegible]

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

SCHEMATIC
SINE SHAPER ASSEMBLY 23020-1

23009 | A

Figure 22. Circuit Card A8

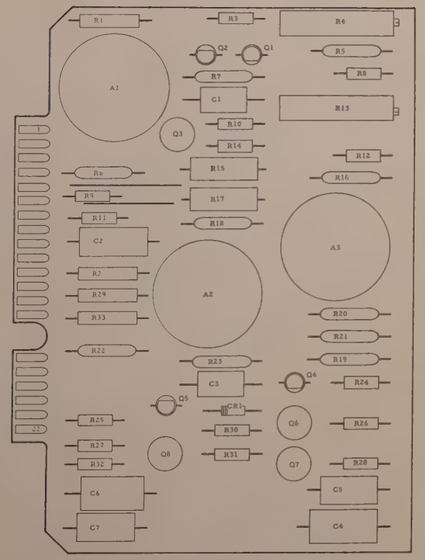
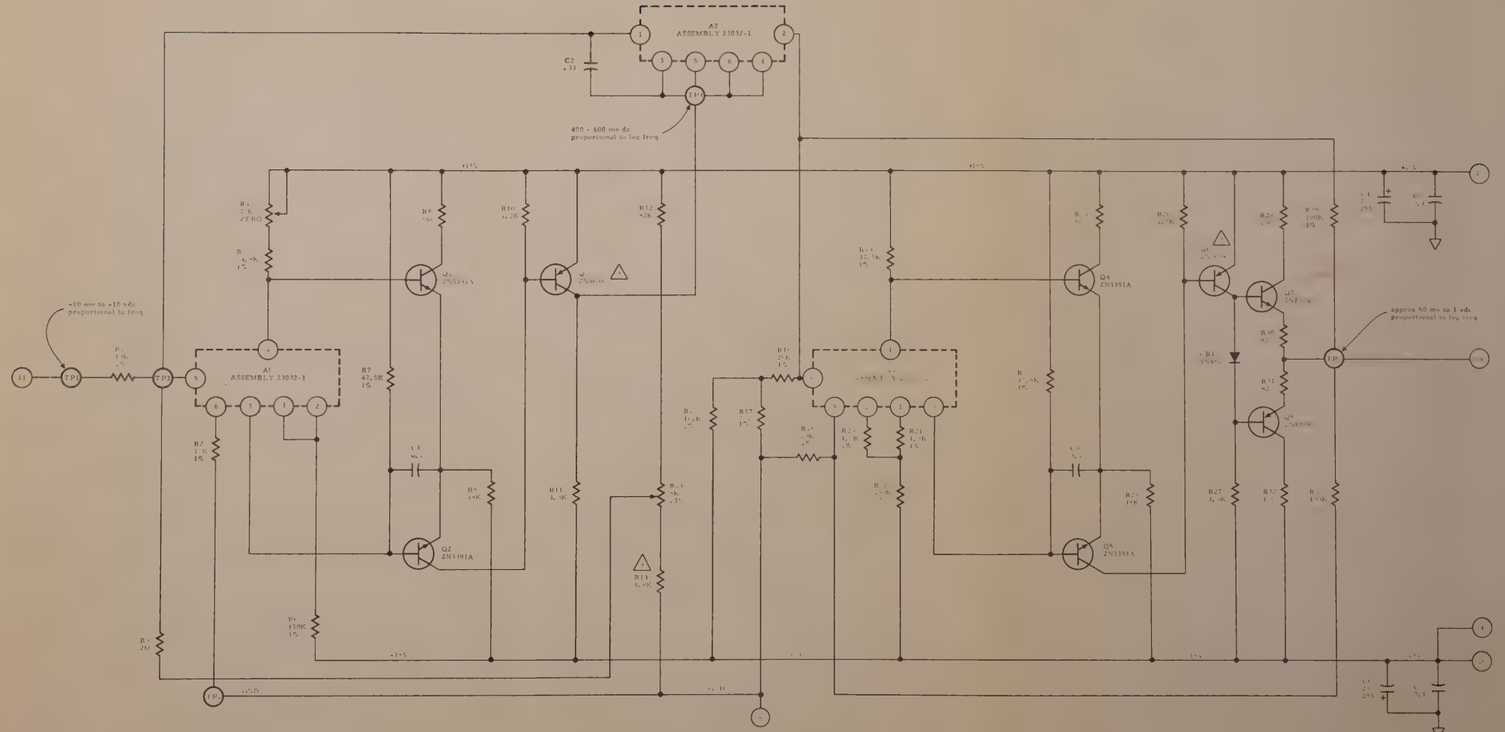
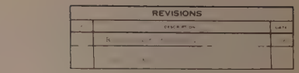


Figure 23. Component Location - Circuit Card A9
Log Converter Assembly 23038-1





NOTES:

△ FOR OBSOLETED.

△

PROPRIETARY RIGHTS OF SPECTRAL DYNAMICS CORPORATION

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

23010 B

Figure 24. Circuit Card A9

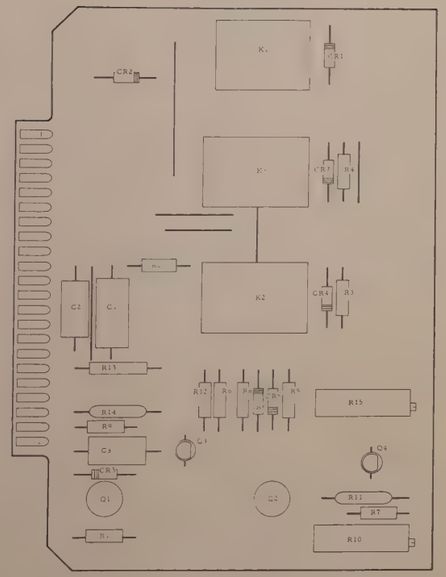
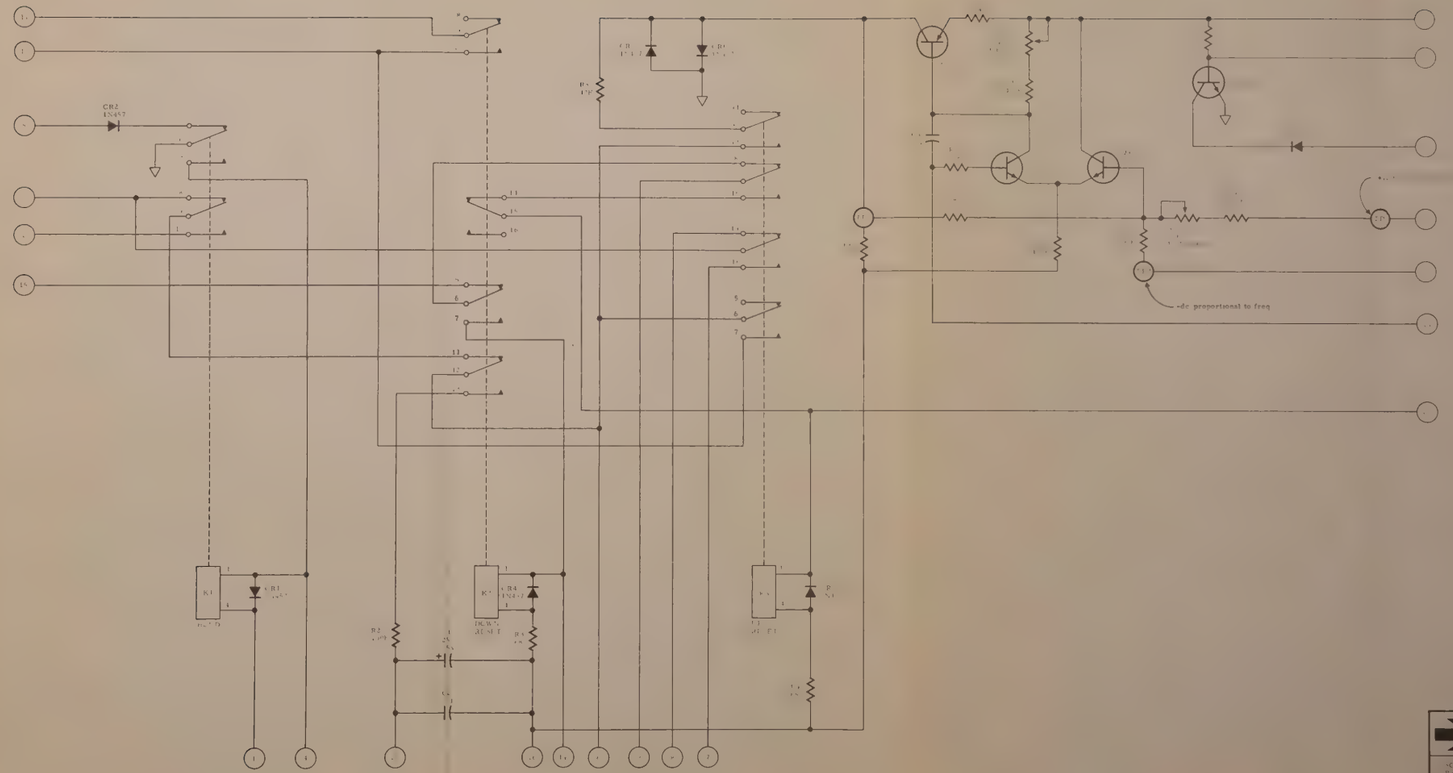


Figure 25. Component Location - Circuit Card A10
Relay Switching Assembly 23044-1



REVISIONS

SPECTRAL DYNAMICS CORPORATION OF SAN DIEGO

23011 A

Figure 26. Circuit Card A10

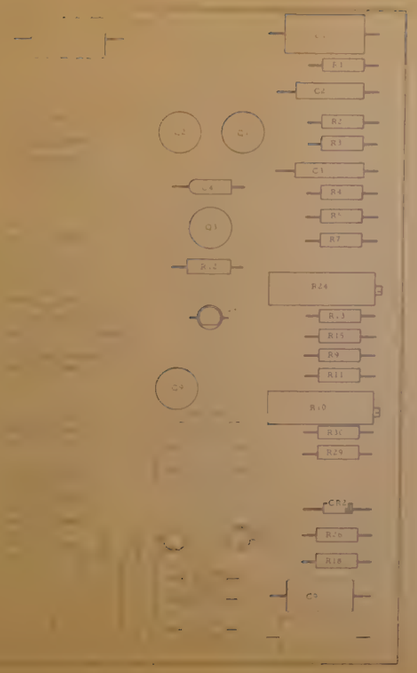


Figure 27. Component Location - Circuit Card A11
Chopper Driver & Output Amp. Assembly 23050-1

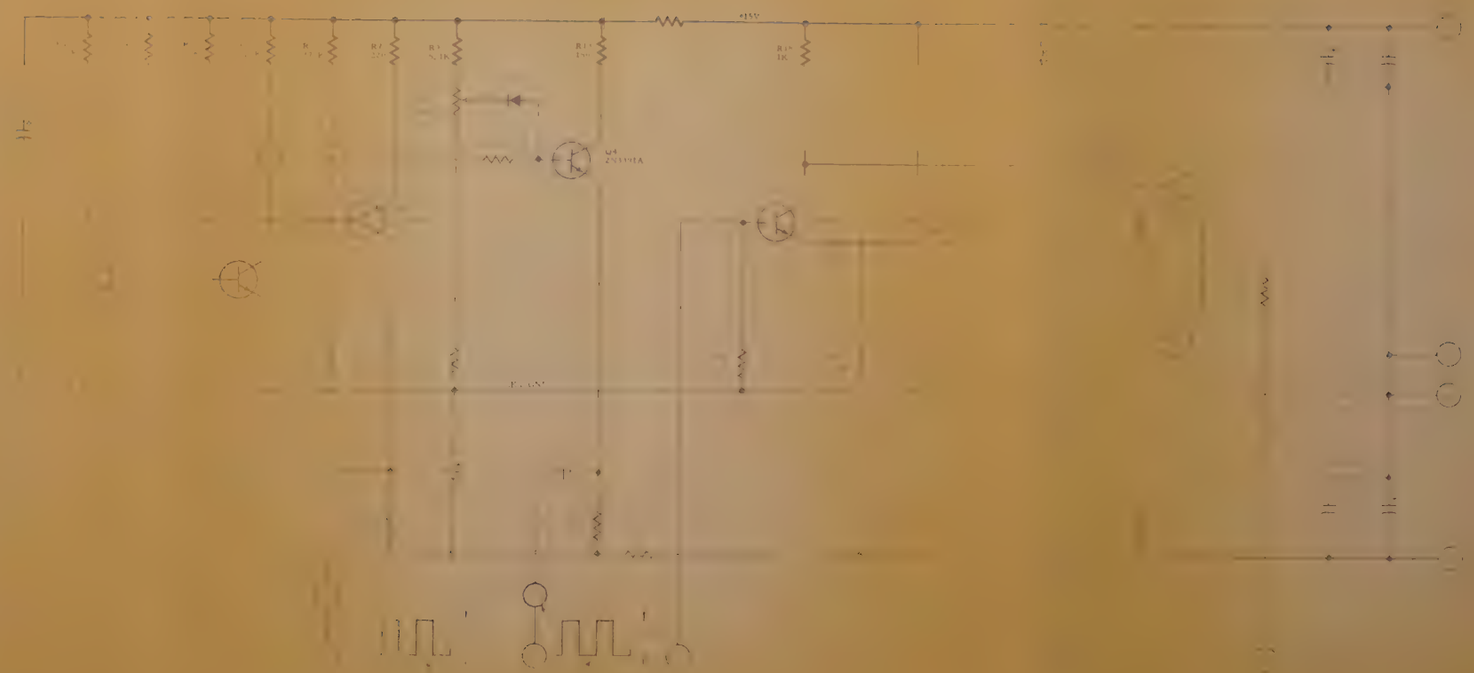
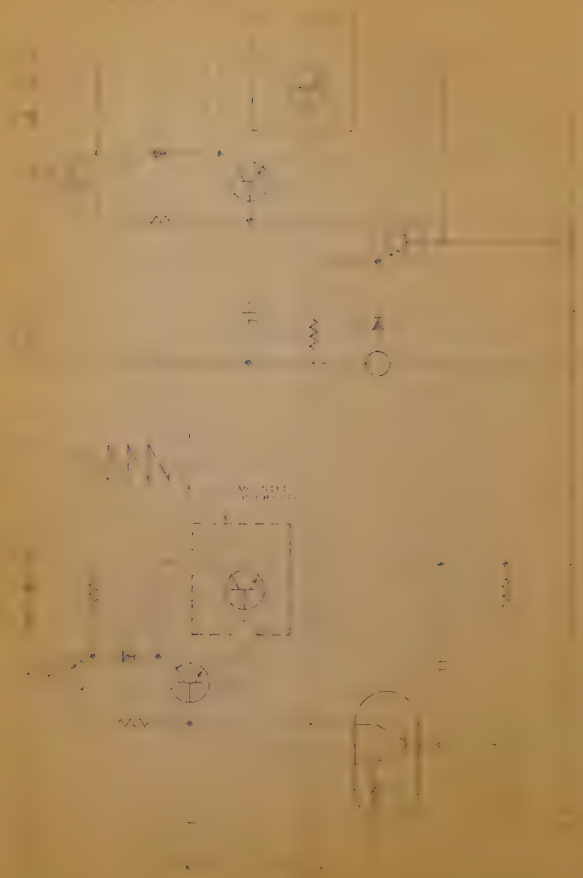
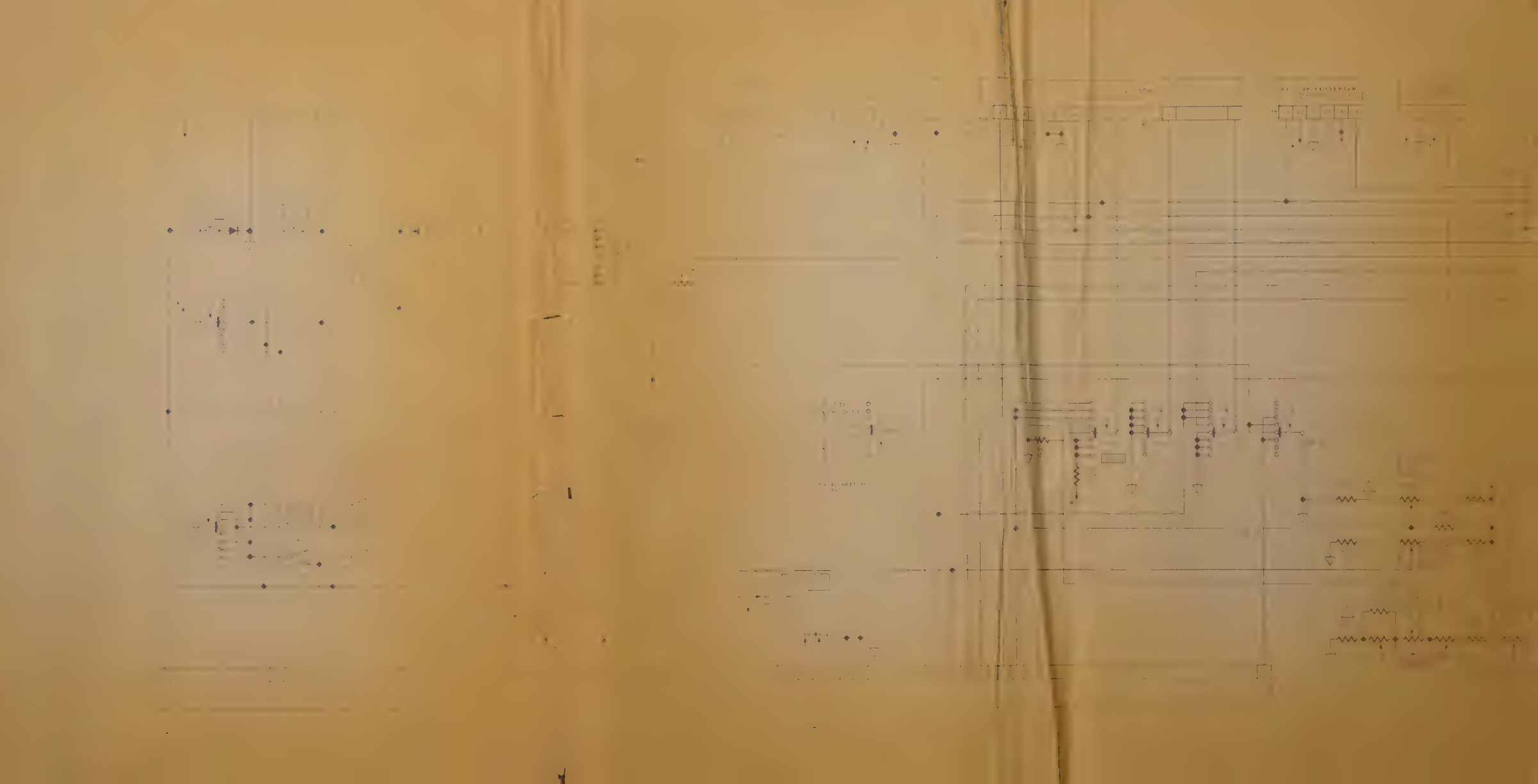


Figure 28. Circuit Card A11

Figure 29. Component Location - Circuit Card A12
Power Supply Assembly 23036-1



Fi gure 30. Circuit Card A12



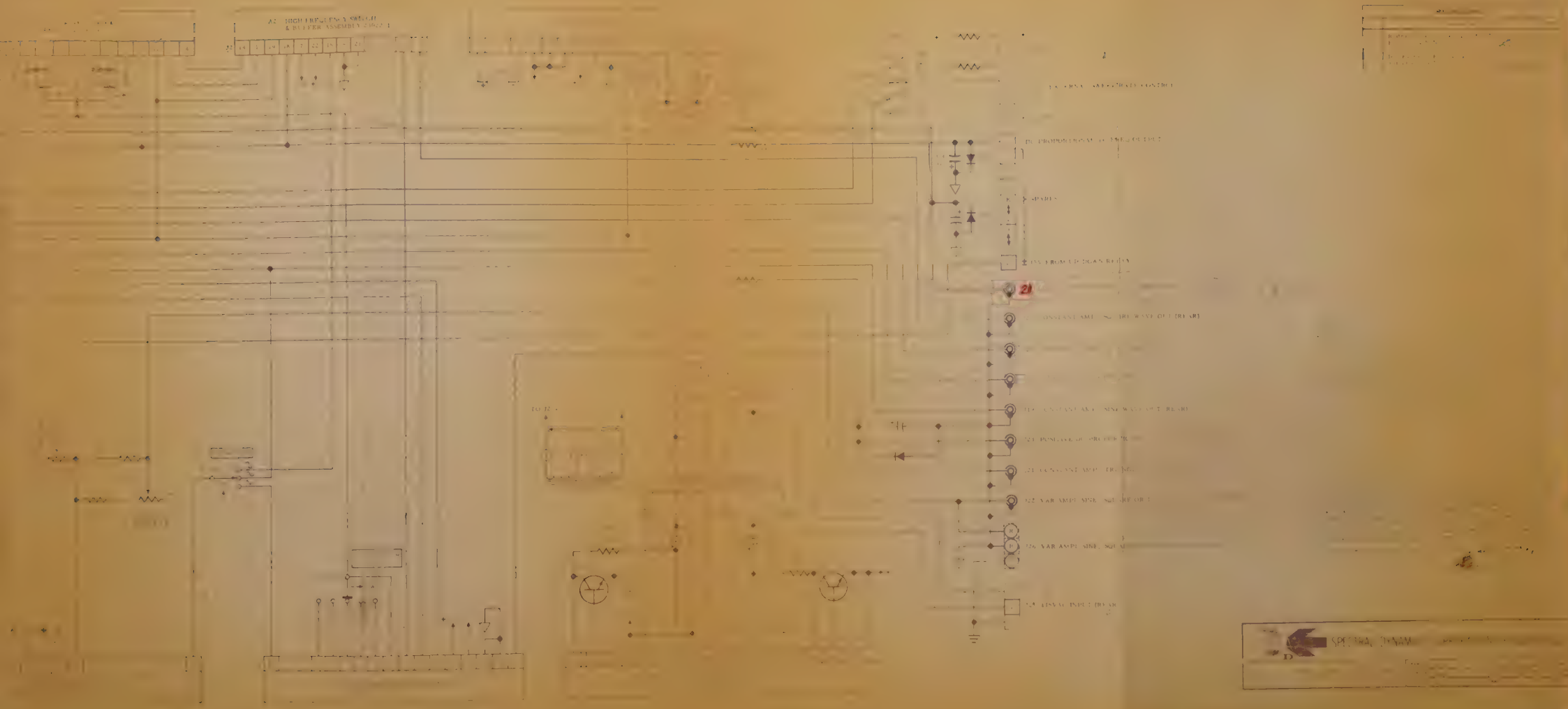


Figure 31. Interconnecting Diagram - Model SD104-5

INSTRUCTION MANUAL ADDENDUM #1

MODEL SD104-5 SWEEP OSCILLATOR

SERIAL NUMBER _____

Rear connector J30 (AUX FUNCTIONS) and toggle switch S12 (SWEEP RATE - INT/EXT) are additional features mounted on the rear of the chassis of this unit but are not shown or described in the Instruction Manual.

The AUX FUNCTIONS connector J30 brings to the rear panel the following circuits:

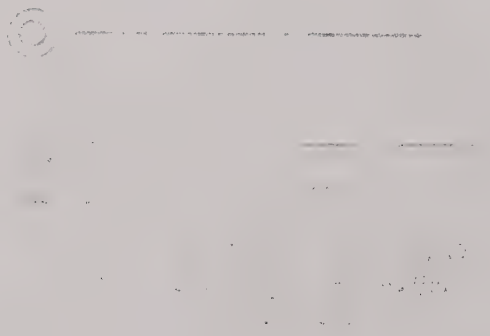
Pin Designation	Description & Function
D	Positive 15 volts dc, regulated. Source impedance 1000 ohms. Short circuit proof.
G	Circuit Ground.
E	Negative 15 volts dc, regulated. Source impedance 1000 ohms. Short circuit proof.
J	Input to the Sweep Integrator. Used for external control of sweep rate and direction. Maximum permissable input voltage is positive or negative 10 volts dc. Input impedance is 1.8 megohms in LOG mode, 5 megohms in LINEAR mode.
H	Sweep control voltage from internal sweep circuit. Connected internally to Sweep Integrator when S12 is in the INT position. Source impedance 1000 ohms or less. Short circuit proof. Output voltage and polarity depends on front panel sweep speed and direction settings.
F	Negative dc-proportional-to-output-frequency. This output is in parallel with rear connector J20. See Instruction Manual for characteristics.
L	Positive or negative 15 volts dc, regulated, depending on direction of sweep. Negative 15 volts dc for UP sweep; positive 15 volts dc for DOWN sweep. May be used for general instrumentation applications. Provides required dc input for SD27 Multi-Filter Selector used in conjunction with Spectral Dynamics Tracking Filters and Dynamic Analyzers. Current drawn from this pin must not exceed 50 ma. A short circuit will not damage the instrument but will cause it to stop operating until the short is removed. This circuit connects directly to the positive or negative dc supply. Output impedance is less than 1 ohm.

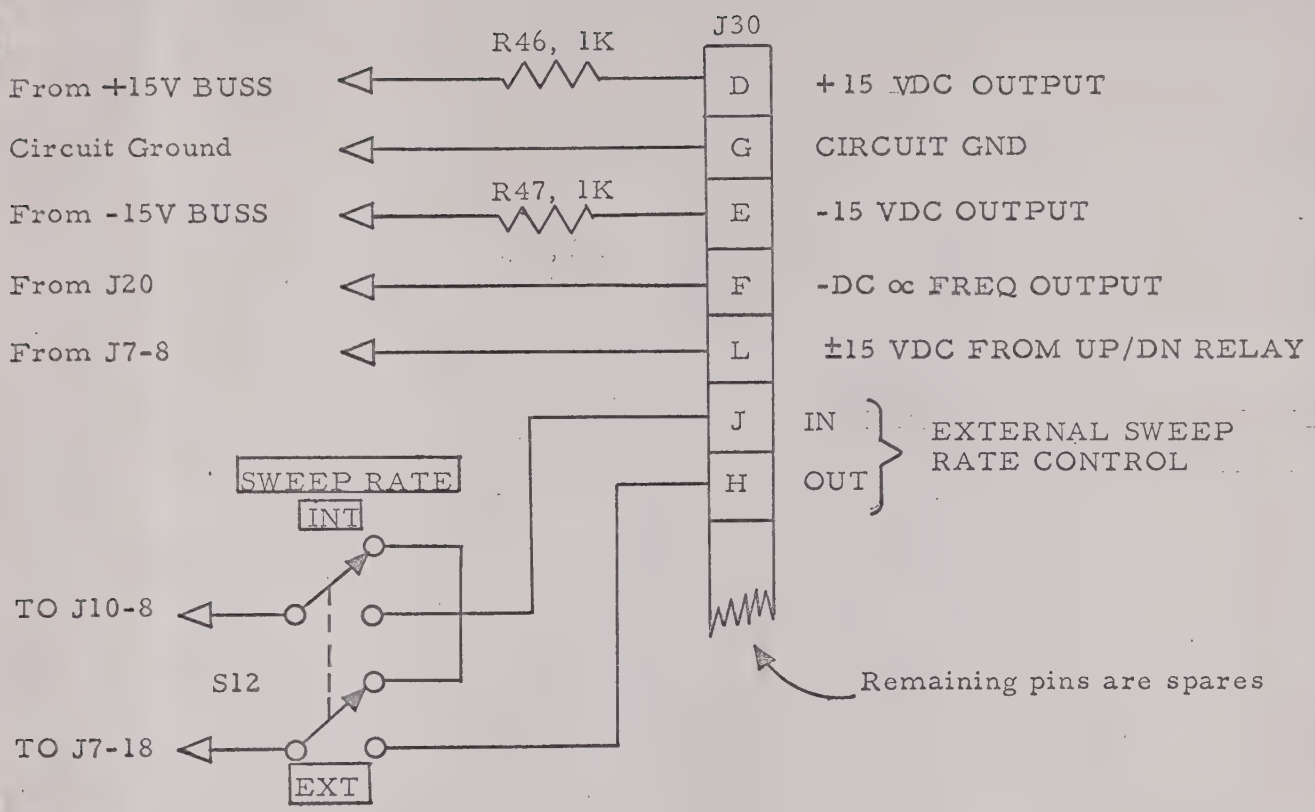
MODEL SD104-5 SWEEP OSCILLATOR - INSTRUCTION MANUAL ADDENDUM #1

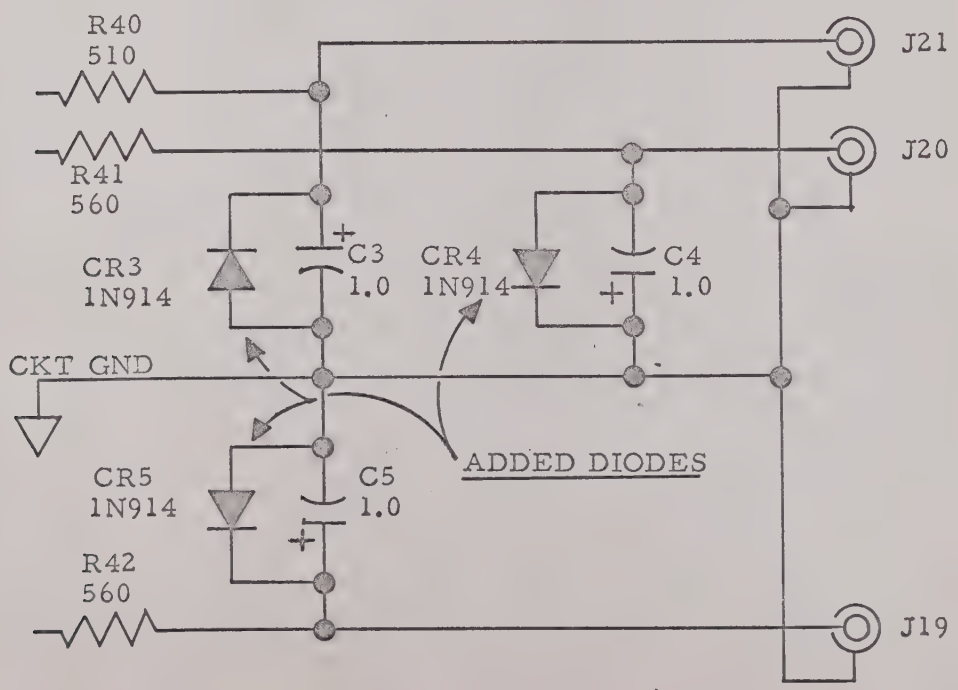
The SWEEP RATE switch S12 determines whether the SD104 sweep rate and direction are controlled internally (front panel), or externally via pin J of J30. For all normal operation, this switch should be set in the INT position.

Capacitors C3, C4 and C5 (1 mfd, 50V) bypass any spurious signals from rear connectors J19, J20 and J21 (See Figure 31 in Instruction Manual - Interconnecting Diagram, DWG. 23001). Diodes (1N914) have been added across the capacitors to protect them against any reverse voltage that might accidentally be applied to the connectors.

The attached drawing and partial schematic shows the modifications described in the above addendum.




J30
R46, 1K
From +15V BUSS
D
+15 VDC OUTPUT
Circuit Ground
G
CIRCUIT GND
R47, 1K
From -15V BUSS
E
-15 VDC OUTPUT
From J20
F
-DC ∝ FREQ OUTPUT
From J7-8
L
±15 VDC FROM UP/DN RELAY
J
IN
EXTERNAL SWEEP RATE CONTROL
H
OUT
SWEEP RATE
INT
TO J10-8
S12
TO J7-18
EXT
Remaining pins are spares


R40
510
J21
R41
560
J20
CR3
1N914
C3
1.0
CR4
1N914
C4
1.0
CKT GND
ADDED DIODES
CR5
1N914
C5
1.0
R42
560
J19

VARIABLE SWEEP RATE MODIFICATION

MODEL SD104 SWEEP OSCILLATOR

1.1 INTRODUCTION

This modification changes the standard SD104 sweep rate control circuit (24 preset sweep rates controlled by a selector switch) to a new circuit having a continuously variable sweep rate feature.

A calibrated dial controls a precision 10 turn potentiometer that, along with a two position multiplier switch, is set by the operator for the exact sweep rate desired.

1.2 SPECIFICATIONS

Logarithmic Sweep: 0 to 10 decades/minute, continuously variable.

Linear Sweep: 0 to 1000 cps/sec. depending on frequency range selected.

Sweep Rate Accuracy (% of setting):

SWEEP RATE Control	Log Mode	Linear Mode
1 - 10	± 3%	± 1%
0.5 - 1.0	± 5%	± 3%
0.1 - 0.5	± 10%	± 10%
0 - 0.1	Usable, but not calibrated	

1.3 OPERATION

When sweeping logarithmically as a sweeping oscillator, the sweep speed, in decades/min., is determined by multiplying the setting of the SWEEP RATE control times the MULTIPLIER (B) control, and multiplying this number by 0.1.

Log (decades/min) = SWEEP RATE X MULTIPLIER (B) X 0.1

Example: To sweep logarithmically at a rate of 0.06 decades/minute, set the SWEEP RATE control at 0.6 and set MULTIPLIER (B) at 1. (The sweep mode switch must, of course, be in a LOG SWEEP position).

By the formula:

Log (decades/min.) = 0.6 x 1 x 0.1 = 0.06 dec/min

When sweeping linearly, the sweep speed in cps/sec is determined by multiplying the setting of the SWEEP RATE control times the MULTIPLIER (B) and MULTIPLIER (A) controls.

Lin(cps/sec) = SWEEP RATE X MULTIPLIER (B) X MULTIPLIER (A)

Example: To sweep linearly at a rate of 0.75 cps/sec with the MULTIPLIER (A) switch set at 0.1, set the SWEEP RATE control at 7.5 and MULTIPLIER (B) at 1. (The sweep mode switch switch must be in a LINEAR SWEEP position).

By the formula:

Lin (cps/sec) = 7.5 x 1 x 0.1 = 0.75 cps/sec

For best sweep rate accuracy, set MULTIPLIER (B) at 1 whenever possible.

Example: A log sweep rate of 0.6 decades/min can be programmed two different ways:

(a) Set SWEEP RATE to 0.6 and MULTIPLIER (B) to 10.
Log(dec/min) = 0.6 x 10 x 0.1 = 0.6 dec/min

(b) Set SWEEP RATE to 6.0 and MULTIPLIER (B) to 1.
Log(dec/min) = 6.0 x 1 x 0.1 = 0.6 dec/min

By formula, both of the above settings give the same sweep rate, but circuit design considerations allow the accuracy of (b) above to be specified as plus or minus 3% of setting, whereas (a) is specified as plus or minus 5% of setting.

1.4 TYPICAL OPERATION

A single linear sweep from 0.2 cps up to 12 cps is desired, with a sweep rate of 0.5 cps/sec. Set MULTIPLIER (A) at .01 (0.05 - 50 cps range), MULTIPLIER (B) at 10 and SWEEP RATE control at 5.0.

By formula the sweep rate is:

Lin(cps/sec) = 5.0 x 10 x .01 = 0.5 cps/sec

Set Sweep Mode Switch to SINGLE (linear sweep). Depress the RESET UP pushbutton and adjust for a reading of 12 in the highest decade (1200 x .01 = 12 cps). Depress the RESET DOWN pushbutton and adjust for a reading of 20 in the lowest decade (20 x .01 = .2 cps). To initiate the single "up" sweep, push the SWEEP UP pushbutton. The total time required for the sweep will be

$$\text{Sweep time} = \frac{\text{frequency difference}}{\text{sweep rate}} \text{ or } \frac{12 - .2}{0.5} = 23.6 \text{ seconds}$$

As described in the preceding specifications, the SWEEP RATE control is usable from 0 to 0.1, but it is not calibrated over this range. Very slow sweep rates may be obtained in this range using the cut-and-try method. With the control set at 0 the sweep circuit is actually in the HOLD mode as far as frequency sweep is concerned. With practice, an operator can slow the sweep down gently to a complete stop, then continue on as desired.

1.5 CALIBRATION OF SWEEP RATE CIRCUIT

The following procedure replaces that given in paragraph 4.13, page 23, of the instruction manual.

(a) Perform paragraph 4.17, HOLD DRIFT adjustment.

(b) Set mode switch in SINGLE (LINEAR SWEEP). Set SWEEP RATE dial to 10 (Make sure dial is correctly zeroed). Set MULTIPLIER (B) to 10 and time a single UP sweep, which should have a duration of 49.95 seconds, plus or minus .4 seconds for a full 3-decade sweep. If necessary adjust FAST potentiometer A7R72 for correct timing.

(c) Set MULTIPLIER (B) to 1. Sweep time should now measure 499.5 seconds, plus or minus 4 seconds. If necessary adjust SLOW potentiometer A7R75 for correct timing.

(d) Return MULTIPLIER (B) to 10 and change mode switch to SINGLE (LOG SWEEP). Time a single UP sweep, which should measure 18 seconds, plus or minus .1 second. If necessary adjust LOG GAIN potentiometer A5R4 for correct timing.

8 min. 20 sec

8.32
60 | 499.5
480
195
180
150